Aalto University
School of Business

# Resilience as a way to improve business continuity: a multiple case study with large Nordic companies

Logistics

Master's thesis

Miikka Mäkilä

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Department of Information and Service Economy
Aalto University
School of Business

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# ABSTRACT

This thesis observes the impacts of business interruptions on business, which is a relatively new area of research. Since the extant theory concentrates mainly on supply chain disruptions the understanding of business interruptions is narrow. Companies suffer increasingly from supply chain disruptions due to just-in-time strategies, globalization and outsourcing, but the risks that threaten companies' business continuity are much more diverse rendering this study to seek answers to fill the gap between practical concerns and current academic research as well as to increase the general understanding of the importance of business continuity.

As risks have soared, companies have become concerned of their business continuity. This study presents the concept of resilience in business context so that the vague understanding of it could be deeper, and applied in the operations to mitigate losses.

The topic is approached by literature research, which aims at collecting the relevant findings about business interruptions. It is followed by a framework, which was created to give a means to evaluate preparedness for risks. As for the empiric methodology, seven theme interviews representing four case companies, and a questionnaire provide the additional material for the research of this topic in practice.

Companies are generally aware of their risks and vulnerabilities, but because the competition is so tough, the resources are so scarce that companies cannot afford costly risk management and resilience methods although they would need them. Therefore, resilience should be targeted to the vulnerabilities so that the resources would be applied optimally. Usually companies cannot invest to all kinds of resilience, so the best use of the money is to find the balance between vulnerability and resilience (Pettit *et al.* 2010).

Risk management and resilience should be taken seriously because business interruptions can have several adverse long-lasting consequences. Hence, the efforts on risk management are very important, especially when business strategies that reduce working capital and redundancies are applied. However, risk management should be economically viable and justified by calculations (Chopra and Sodhi 2004, and Norrman and Jansson 2004).

**Keywords**

Business interruptions/continuity, resilience, risk management, risks, incidents.

AALTO-YLIOPISTON KAUPPAKORKEAKOULU TIIVISTELMÄ
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# TIIVISTELMÄ

Tässä gradussa tutkitaan liiketoiminnan keskeytyksen vaikutuksia liiketoimintaan, joka on suhteellisen uusi tutkimusaihe. Aihepiirin ymmärrys on suppea, koska aiemmat tutkimukset ovat keskittyneet lähinnä toimitusketjun häiriöiden tutkimiseen. Vaikka yritykset kärsivätkin lisääntyvästi näistä häiriöistä johtuen just-in-time-strategioista, globalisaatiosta ja ulkoistamisesta, yritystoiminnan jatkuvuutta uhkaavat riskit ovat niin monimuotoisia, että tämä tutkielma pyrkii löytämään vastauksia käytännön ongelmiin, joista ei ole aiemmissa tutkimuksissa puhuttu, sekä lisäämään ymmärrystä liiketoiminnan jatkuvuuden tärkeydestä.

Riskien lisääntyessä yritykset ovat huolestuneita jatkuvuudestaan. Työni avaa resilienssin (kyvyn palautua nopeasti ennalleen) käsitettä liiketoiminnan kontekstissa, jotta nykyinen hatara käsitys siitä voisi selkeytyä ja olla avuksi liiketoiminnan vahinkojen minimoimisessa.

Lähestyn aihetta ensin kirjallisuustutkimuksella, jolla kokoan merkittävimmät havainnot liiketoiminnan keskeytymisen vaikutuksista. Sen jatkoksi kehitelty malli auttaa arvioimaan valmiutta kohdata riskejä. Empiirisinä menetelminä käytetään seitsemää teemahaastattelua neljästä case-yrityksestä, sekä kyselytutkimusta, jotka muodostavat tutkielman empiirisen materiaalin.

Yleisesti ottaen yritykset tuntevat riskejään ja haavoittuvuuksiaan, mutta kova kilpailutilanne ei salli resurssien tuhlausta, jolloin riskienhallintaan ja resilienssiin käytettävät resurssit ovat ehkä tarvittavia pienemmät. Sen vuoksi olisikin tärkeää kohdentaa resilienssi haavoittuvuuksiin, jotta resurssit tulisivat optimaalisesti hyödynnettyä. Firmat eivät yleensä pysty investoimaan resilienssiin kaikenkattavasti, joten haavoittuvuuksien ja vastaavien resilienssin keinojen välille olisi tarpeellista löytää tasapaino (Pettit ym. 2010).

Riskienhallinta ja resilienssi tulisi ottaa vakavasti, koska keskeytysvahingot voivat aiheuttaa lukuisia haitallisia ja pitkäkestoisia seurauksia. Siksi riskienhallintaan panostaminen on tärkeää varsinkin jos käyttöpääomat on minimoitu. Riskienhallinnan tulisi kuitenkin olla taloudellisesti järkevää ja perusteltu taloudellisilla laskelmilla (Chopra ja Sodhi 2004, ja Norrman ja Jansson 2004).

**Avainsanat**

Liiketoiminnan keskeytyminen/jatkuvuus, resilienssi, riskienhallinta, riskit, vahingot.

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# CONCEPTS AND DEFINITIONS

There are a few concepts repeating very often in this study that will be introduced and explained in this part.

**Risk**

Risk has been defined in this work as follows: “Risk is the chance, in quantitative terms, of a defined hazard occurring. It therefore combines a probabilistic measure of the occurrence of the primary event(s) with a measure of the consequences of that/those event(s).” (The Royal Society, 1992, p. 4)

Although the International Organization for Standardization (ISO) has redefined the concept of risk to be “the effect of uncertainty on objectives” instead of calculation of the likelihoods of only negative consequences (ISO 31000), both definitions will suffice in this context, because business interruptions have so far showed mainly negative consequences without significant positive risks. However, business interruptions may be triggers to new business concepts and renewals that may have positive impacts in the long term.

**Risk management**

“Risk management is the making of decisions regarding risks and their subsequent implementation, and flows from risk estimation and evaluation.” (The Royal Society, 1992, p. 3)

**Business interruption**

Business interruption does not have a specific definition in the academic literature. However, this is a central concept throughout the thesis, so it is necessary to define what I mean with it. Business interruption means that a business has to halt its operations partially or completely due to a disruption in its internal or external environment. (See also business continuity, which is an antonym for business interruption.)

**Business continuity**

Business continuity and interruption are mutually exclusive concepts regarding the running of the operations. One given definition for business continuity is that it is "the capability of the organization to continue delivery of products or services at acceptable predefined levels following a disruptive incident." (ISO 22313:2012(E), p. vii)

**Contingent business interruption**

Contingent business interruption (CBI) is a more specific term related to business interruptions. The difference between the two is that contingent business interruption stems from disruptions at external sites. It means that a business has to interrupt normal operations due to an inability of the supplier to deliver supplies, the inability of customer to receive products, or a disruption of other external parties such as utility providers, logistics operators or other facets. In this case, the focal company does not suffer from physical damage at their own sites.

**Supply chain/network disruption**

Supply chain disruptions are the most common topic related to business interruptions in the research material. They are defined as "unanticipated events that interfere with normal flow of goods and/or material in a supply chain" (Craighead *et al.* 2007, p. 132). It is not, however, clearly defined how often disruptions cause production to stop and how often it only slows it down.

**Supply chain risk management (SCRM)**

"Implementation of strategies to manage both everyday and exceptional risks along the supply chain based on continuous risk assessment with the objective of reducing vulnerability and ensuring continuity." (Wieland and Wallenburg 2012, pp. 890-891)

**Dependency**

Dependency in general means that a company or other entity is dependent on other entity in such way that once an event affects the other party, the dependency renders the effects

to some extent also to the dependent party. As Hallikas *et al.* (2004) have studied, the dependency becomes stronger while the collaboration between other entities deepens.

**Interdependency**

Interdependency is a hyponym of dependency related to two-way dependency, where both or all parties are dependent on each other.

**Internal dependency**

Internal dependency and interdependency should not be confused. As interdependency meant mutual dependence, internal dependency means dependency between units within a single entity.

**Resilience**

In a nutshell, resilience is a mix of methods that enable faster recovery from business interruptions or other adverse events. For a more comprehensive definition of resilience see (5.1 Defining resilience), because the concept in business context is rather new without an established definition.

# 1. INTRODUCTION

Increased risks in business practices have increasingly induced adverse consequences for companies during recent years. Fierce competition and cost minimization pressures have forced companies to apply strategies that are not pleasing risk managers. Companies have adopted the habit of sourcing from cheaper countries, which is businesswise easily understandable, because the less it costs, the bigger the margins and the greater the profits. However, activities moved into more distant and less familiar regions will expose the whole supply chain to new and unfamiliar risks. Furthermore, Silva and Reddy (2011) claim that reaction time increases while outsourcing becomes prevalent, and long distances owing to globalization mean prolonged deliveries which expose the goods to more hazards. Evidently, the result is greater propensity to disruptions. More than one part from each dimension in COSO's (2004) enterprise risk management (ERM) model have been considered in this work. However, this is not supposed to analyze ERM itself but link the relevant contents of the model into resilience and the bigger picture of companies' risks and the consequences of losses.

Companies have embraced situations and conditions, which threaten the business continuity. There are challenges that complicate the situation and make managers struggle with: Bello and Bovell (2012) note that risk mitigation activities are not free, and thus, their economic viability should be verified. Furthermore, the uncertainty of risk realization can make the justification of the investments challenging if top management and investors have not been adapted to risk management culture (Zsidisin *et al.* 2000). As a result, top management may be reluctant to give risk management enough resources to manage risks adequately leading to vulnerabilities and higher tendency to see incidents. However, academic literature has a very little to say about business interruptions making this study a pioneering study towards a coherent picture of business interruptions. Until now, the theory has been scattered into smaller pieces typically considering supply chain disruptions instead of more severe incidents that could lead to long periods of business discontinuity. Research material does not provide strong opinions on the consequences and prevention of the events. Companies struggle with risks and their vulnerabilities constantly because the business environment has evolved to the situation where redundancies and means of

resilience may take the critical share of the margins so that investors do not accept the reduction of profits from the short term for the longer term business (and profit) continuity.

Therefore, there is an evident gap between practical demand for this study and the deficit of the theoretical literature. This study contributes to the missing parts of the content with which practitioners are struggling. The theory tends to be very conceptual and find general models that every company could use, but the problem is that the real challenges in the companies require detailed and practical, down-to-earth solutions. When the problems differ from each other, it, in turn, makes the creation of theories and models challenging.

This study is an important addition to the field of this topic, because the impacts of business interruptions are seemingly high, but the knowledge of the consequences both in short and long term could be better. This thesis could be a useful package of basic theories and cases related to business interruption risks and events paired with a Risk Readiness Evaluation Tool to evaluate resilience, which can be applied by risk managers and other decision-makers in companies.

**Limitations of the study**

This work cannot give answers to everyone, but instead, have many limitations that should be noticed. This thesis suits best for production companies, but to some extent has also content for every kind of companies. Service providers, non-governmental organizations (NGOs), public agencies, military organizations and other non-profit organizations (NPOs) are not outside the target organizations of this study, but the premises for the analyses have been large companies having manufacturing, assembling or other operations related to physical products or parts. Therefore, small and medium enterprises may find irrelevant substance for their current situation even though they would be manufacturing companies. Nevertheless, learning about business interruptions and resilience beforehand can prevent many mistakes when managers start expanding the business.

IT perspective is not at the core of this study, but it is discussed in dependencies and continuity planning parts. IT issues have been studied already much better than many other focus points, so this study tries to find answers mainly to logistics and operational processes.

The breadth of this study is so wide that some interesting topics had to be left out from the observations. Man-made hazards such as terrorism, strikes, vandalism, hacking and such intentional attacks have become a severe threat for security and especially IT security. Those acts are doing harm for many companies that are famous or raise moral issues in the public. Another topic left out from discussion is early warnings that would be of great interest, because preparedness mitigates the effects of events substantially. Unfortunately, all incidents faced by case companies of this study were total surprises for the companies without realistic possibilities to predict it beforehand due to their accidental nature. Therefore, early warnings could relate better to environment, political instability, technology and other non-accidental events.

**Earlier literature on the main topics**

The literature on business continuity and supply chain risk management has been growing since the turn of the millennium, which provides a good basis for a review of that part of the topic. The focus of the literature is clearly on the supply chain disruptions, and the effects of disasters, but there seems to be more and more research on resilience, yet not plenty of articles. The literature regarding property risks, process risks, construction risks and consequent business interruptions is very limited. Since the objective is to create a thorough research on the business continuity, supply chain perspective is not the only target, albeit it takes my pivotal attention.

An MIT professor Yossi Sheffi has written a book titled Resilient Enterprise (2005), which has widely covered the main topics of the theory in this study. The book consists of a wide review of the theory related to supply chain management and resilience, and it has a good arsenal of cases regarding each topic. In addition to the book, resilience is covered in a few articles that expand the perspective to the topic. Another useful book used in this study is Supply Chain Risk (2009) edited by Zsidisin and Ritchie. The book consists of several areas of supply chain risks, sourcing strategies, and SCRM in general.

Other main topics that are found in the articles are collaboration, complexity of the supply network and process design, risks that can cause disruptions, risk management, vulnerability of the company or the supply chain due to global supply chains, business continuity planning, and agility and responsiveness of the supply chain. Business

interruption itself seems not to be a popular topic, but the aforementioned factors each are contributors to business interruptions.

The science of business continuity and resilience has taken some steps from early 2000's until recent years, but there is room for going deeper in the theories and paradigms. The focus of this study is to give an overview of the findings as well as bring the writer's own contribution to the business interruption and continuity topic by empirical analyses based on the observations, experience and knowledge by companies that participate to the empirical part.

To put it concisely, the core problem of the research of business interruptions is that the literature makes a very limited match with the practical concerns by risk management professionals. Academic research has very narrow content for best practices in business interruption recovery, the analysis on the factors that affect most to the business interruption losses and the market situation. Discussions with professionals at If Insurance P&C have given additional knowledge of the matters that are taken into consideration in practice, but the main source of the knowledge comes from deeper discussions with company representatives.

## 1.1. Research questions

This study aims at finding the theoretical basis for business interruptions so that the understanding of this topic would expand, and the theory could be used in the practical decision-making. Business interruptions are affected by a number of factors, and quite many of those are discussed in the thesis. This work balances between the depth of the analysis of each factor and comprehensiveness of the variety of the factors that have been taken into discussion. Many factors with deep analysis would require much more efforts and would make the report heavy, so to stay within the limits of a thesis, this study leaves a plenty of future research possibilities.

The main objectives of the thesis would be to find answers to the following five research questions. There are two research questions related to the extant literature and the need for updating or creating new frameworks for analyzing business interruptions, and three

research questions related to the theory of business interruptions. With these questions I approach the challenge in order to get a better and clearer picture of the topics.

1) Does the scientific literature provide any feasible models for assessing the business interruption risks, vulnerability, or consequences?
2) Can the model presented in this work be used in defining the companies' risk management or resilience preparedness for business interruptions?
3) What are the critical factors affecting the size of the business interruption losses?
4) How can companies prevent themselves from business interruptions?
5) What are the critical factors affecting while returning to markets?

## 1.2. Outline of the study

The structure of this thesis follows a common sequence to start with introduction to the topic with literature review, gap between the earlier research and the actual need for knowledge about this field at the practical level, and the research questions. Chapter two introduces the research methodology by which the analyses and conclusions have been made. It elaborates the theory part, empirical methods, and the framework, which was created based on the theory and also partly the findings from empirical material. Next chapters relate to the theory of business interruptions, risk management, which helps in avoiding business interruptions, and thirdly resilience as an answer to the business interruption impact mitigation. Chapter six introduces the framework and a resilience tool with which users can evaluate their preparedness and ability to withstand adverse events. The empirical analysis and results are presented in the chapter seven, and they are discussed in the following chapter with respect to theory. Chapter nine concludes the most important findings of this study.

# 2. RESEARCH METHODS

The chosen ways to observe the problems follow the guidelines given by Hirsjärvi and Hurme (1980, p. 15) whereby the objective(s) to *understand* specific phenomena should be approached with qualitative methodology. The methods have been chosen to fit to the objective of this study. The fact that there are different methods used gives stronger evidence because the methods are complementing each other. The most important method of my study is theme interviews that fit well to the research objectives in order to get information about the relatively new topic that has not established strong paradigms. It is common to find requests for clarification, elaboration, and validation of the initial results in the discussion parts of the research literature. I found several statements about the incompleteness of the research area, and suggestions for future research (see Table 2.1).

Another significant method of this thesis is a literature research. One objective of it is to find out whether the existent research would have found a model or a tool for analyzing business interruption incidents or resilience. Another objective is to find background knowledge of the three research questions related to the theory of business interruptions so that the empirical research would have a basis, which the interviews and the questionnaire can be compared to.

It is typical for case studies to have different methods to gather data and observations (Eisenhardt 1989) and therefore I decided to take a wider perspective than theme interviews and literature research. The third method included is a structured web-based questionnaire that provides data about companies' losses, risk management, resilience methods and the factors that have affected the size of their losses. Based on the data I can deploy quantitative methods that can explain the phenomena related to this study (Hirsjärvi and Hurme 1980, p. 16). Observations, however, are not an applicable methodology due to the rarity and long duration of the business interruption events. Hence, the chosen methods outweigh the alternative methodologies. (The word 'interview', in fact, can mean in-depth interviews, theme interviews, or questionnaire forms (Hirsjärvi and Hurme 1980, p. 43), but to make it simple, I use word 'interview' when talking about conversational interviews, and 'questionnaire' when talking about surveys in other formats (web, paper, etc.).)

**Table 2.1 Researchers' opinions on the topic**

| | |
|---|---|
| "…the need for a structured approach to the management of supply chain risk was identified" | Christopher and Peck 2004, p. 11 |
| "The interrelation between supply chain risk management and current logistic/supply chain management principles is not clear, and we find this to be an interesting field for future research." | Norrman and Jansson 2004, p. 454 |
| "From both practical and research perspective, the knowledge base on how to avoid and manage supply-chain disruptions is in its infancy." | Blackhurst *et al.* 2005, p. 4078 |
| "Supply chain vulnerability and indeed resilience is wider in scope than integrated supply chain management, business continuity planning, commercial corporate risk management or an amalgamation of all of these disciplines." | Peck 2005, p. 225 |
| "Since supply chain risk management is a relatively new area of research, there are many research opportunities." | Tang 2006b, p. 43 |
| "This study, while providing initial findings…needs to be supplemented with additional studies… We therefore highlight the importance of additional research in this promising area." | Bello and Bovell 2012, p. 96 |

Further evaluation and comparison of the methodologies say that interviews are superior to questionnaires in many ways, but the two most important reasons are: (1) interviews are flexible, which enable further elaboration on the most important topics and let the interviewer make changes to the structure during the interview (Selltiz *et al.* 1962 cited by Hirsjärvi and Hurme 1980, p. 29), and (2) interviews suit better for topics that are somehow sensitive (Sanford 1966 cited by Hirsjärvi and Hurme 1980, p. 29), which is the case in my study where the topics cover accidents, failures, losses etc. On the other hand, questionnaire material is a lot easier to handle and analyze compared to recorded material from interviews, but the predefined answer alternatives and topics of the questionnaires can rarely match the way the respondent sees the problems (Hirsjärvi and Hurme 1980, pp. 30, 43). The authors (ibid. p. 30) add that interviewing is more challenging and time-consuming method with quite much irrelevant material, and smaller level of anonymity.

However, I have undisclosed the identity of the case companies by revealing only their industry and some other general information. The fact that industries are not niche industries guarantees that there are so many possible firms that could represent the case company that the identity of the real case company remains secret.

While the interview was chosen as the main method, it can be justified as the most suitable form from the three aforementioned formats: in-depth interviews, theme interviews and questionnaires. Ignoring questionnaire in this context (despite officially being one form of interviews) I chose theme interview over in-depth interview because theme interviews allow flexibility regarding additional questions and use of time for each topic. In-depth interviews are suitable for really difficult and sensitive issues such as personal problems of people (Hirsjärvi and Hurme 1980, p. 45) and thus, this could be more common to implement in the area of humanism but because the questions that I will ask in the interviews are not sensitive in that way, in-depth interview lacking structure could be probably worse decision because the predefined questions of theme interviews steer the conversation towards the topics that should be concentrated on. Furthermore, the quality of the answers will probably be higher when I am able to send the questions beforehand to the respondents so that they can prepare for the answers. Using in-depth interview such possibility lacks.

## 2.1. Theme interviews

I have interviewed four companies with seven interviews altogether. Initially, the intention was to have five companies and two interviewees from each company, but due to the sensitivity of this topic, some companies refused to participate. However, I managed to find four cases which is enough for thesis level study according to Eisenhardt (1989), who asserts that 4 to 10 cases would be suitable amount, but she also states that it is common to plan the amount of interviews beforehand even though the optimal amount would be right before the saturation of the data. That means that material should be added as long as it provides essential information and is useful for the study. Otherwise, it is just wasting time and other resources. However, the optimal number of cases cannot be known in advance, so the undecided amount of cases would be better in that sense.

The companies I interviewed represent food and beverage industry, and metal industry. The fact that there are two companies from both industries helps me to see if there are commonalities and differences within the industry. It is also good for the study that the industries are very different from each other; food and beverage industry produces consumer products and faces a whole different requirements as for legislation and cleanness, for instance, whereas the case companies operating in metal industry produce components and refined material for industrial clients with regulations regarding safety in production processes and material handling. It was advised to have more than one interview per company in order to gain more truthful view of the topics because different persons may have different perceptions on the same things. Interviewing people in different positions turned out being useful, and I also received better knowledge related to different topics because one person does not necessarily have the answers to all questions.

In the empirical part, I will denote the case companies as follows: food and beverage companies will be named FOOD1 and FOOD2, and metal industry companies similarly METAL1 and METAL2.

## 2.2. Questionnaire

A web survey was conducted in order to receive data from the markets and getting additional insights about the incidents, factors that affected the size of the loss, risk management, and resilience. The format of the survey was multiple-choice questionnaire, which gives simple distributions of the answers. Because interviews already give unique answers, this does not have to go that much into detail, but instead, give more general picture of the situation overall.

The questions were designed to be relevant, easy to answer and few in number so that the responding would not take too much time and so that the amount of responses would be as high as possible. The survey was published in mid-February 2014 and respondents had 23 days (17 working days) to finish the survey. It was sent by account executives of If Insurance P&C to If's 38 client companies' risk managers or CFOs, of which 20 responded (and of which one empty form). Hence, the response percentage climbed up to 53, which is

an excellent result. That was the major reason to choose account executives as the senders so that the receivers would trust to the source and be willing to respond.

Although the sample is small, the distributions show quite well which factors are common and which not. General demographics of the sample show that 89 percent of the respondents represented industrial activities, and 16 percent services. The number does not sum up to 100 because one company represented both industrial activities and services. 50 to 60 percent had revenues over €1 billion, while the rest 40 to 50 percent divided quite equally between €100-500 million and €500-1000 million. Number of employees correlates with revenues very closely; 50 to 60% had over 5 000 employees, and 40 to 50 percent was divided between 501-2000 and 2001-5000 almost equally. Over two thirds operate in at least 10 countries and 37% in over 30 countries. Two companies (11 percent) had not faced incidents. Further details of the survey are shown in appendix 2.

# 3. BUSINESS INTERRUPTION INCIDENTS

Business interruptions can derive from a number of different factors. The aim of this chapter is to give a better understanding of the causes and consequences of such events. A good understanding of this topic can make companies give more attention to risks leading to business interruptions and their prevention, which is discussed in chapter 4.

There could be many ways to categorize risks by the underlying factors, but the writer has combined a table of seven elements, which play some role in the business interruption risks based on research literature and discussions with practitioners (see Table 3.1). The table considers the origins of the risks as well as the target they have. The causes include both internal and external factors, and can stem also from other factors than listed. Businesses are so complex and interconnected that the target of the risk can be even far from the actual site and still have interrupting impacts on the operations. Therefore, the targets have been defined very widely. The impact of the event may relate only to the single company (micro-level event) while macro-level events induce consequences for multiple facets. Severity and likelihood are the most common ways to quantify the risk, but detectability of the risks, and vulnerability of the entity support the analyses of risks.

**Table 3.1 Elements regarding risks**

| Cause | Consequence target | Consequence scale |
|---|---|---|
| Internal operations | Property | Micro-level |
| Business environment | Product | Macro-level |
| Natural environment | Supply chain | |
| Economic | Finance | |
| Technological | Employees | |
| Geopolitical | Reputation | |
| Social | Infrastructure | |
| | Information | |
| | Society, safety, environment | |

| Severity | Likelihood | Detectability | Vulnerability |
|---|---|---|---|
| Very low | Very low | Very low | Very low |
| Low | Low | Low | Low |
| Medium | Medium | Medium | Medium |
| High | High | High | High |
| Very high | Very high | Very high | Very high |

Christopher and Peck (2004) have created a widely applicable framework, which categorizes supply chain disruptions into three major categories: *internal* risks, *external to the firm but internal to the supply chain* risks, and *external* risks. More specifically, the internal risks include process risks and control risks, the second category splits into demand risks and supply risks, and the external risks encompass a plethora of risks that are not limited to the focal company or its supply chain but are macro risks so to speak (ibid.). To make it more concrete, Asbjørnslett (2009, p. 27) lists that the internal factors relate to people, systems, maintenance, and organization, whereas external factors include markets, environment, society, and infrastructure among others.

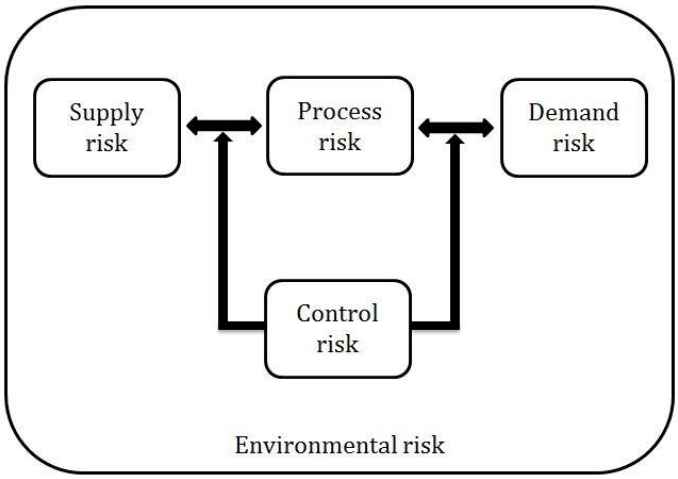


**Figure 3.1 Risk sources (Christopher and Peck 2004)**

This model does not consider the micro and macro risks separately or even classify them, but only defines the origins of the risks. To give a broader scope to the theme, Casualty Actuarial Society (2003) categorizes risks under hazard risks, operational, financial, and strategic risks. These, however, do not take the risk sources into account as the previous model does. Research literature provides plenty of models that handle risks, but there seems to be lack of comprehensive models that would be functioning tools for practitioners. However, the application of the models is easier and probably more useful when they are simple enough. The difficulty faced by researchers is probably finding the balance between the usability and comprehensiveness of the model.

**Different interruption types**

Each business interruption event is unique, but a structural approach would give a better understanding of the different interruption types. In broader view, there are two generic sources that can induce business interruptions: property damage and other 'events' that do not derive from property damage. They can occur internally or externally, and induce micro (one company) or macro (many companies) level impacts. These premises generate eight different general scenarios, which follow.

1. Internal property damage → micro business interruption
2. Internal property damage → macro business interruption
3. External property damage → micro business interruption
4. External property damage → macro business interruption
5. Internal event → micro business interruption
6. Internal event → macro business interruption
7. External event → micro business interruption
8. External event → macro business interruption

The first scenario is of common type, because many smaller incidents occur on-site affecting their operations to halt, but being small enough for their customers to be covered by inventories or other suppliers. The second could be a severe fire or other damage on-site which stops also other companies' operations. Third scenario means that an external entity induces a business interruption for only one other company; a rare event, but possible if business is complex and dependencies are strong. The fourth scenario would be a large-scale damage at an external site, but which has wider than internal impacts. Scenarios 5-8 correspond to scenarios 1-4 with the difference that there are no physical damages but changes in business environment, regulations, competition, technologies, and strikes whatsoever.

Internal incidents are often fires, machine breakdowns, process flaws, chemical accidents, construction damages, and installation failures (If Insurance P&C). External incidents derive from these same factors on suppliers or customers' sites, or from disruptions stemming from physical damage at utility or logistics providers' facilities. Examples of internal events are employee disputes, inadequate safety and maintenance breaks. External

events can be strikes at certain point of logistics or supply chain, changes in technology, riots, wars and political instabilities, natural conditions such as ash cloud, and strong economic downturns.

Business interruption has not been clearly defined in the literature. Disruptions, in turn, have been mentioned and defined more often, but even though they are closely related, they are not synonyms. Disruptions are the cause, and interruptions the consequence. However, based on the experience by the writer dealing with business interruption incident reporting, it could be defined as follows: business interruption means that a business has to halt its operations partially or completely due to a disruption in its internal or external environment. Business interruption has two distinctive periods (see Figure 3.2): the time when the affected operations are totally down (called technical loss period), and the time when the operations can be restarted partially or completely until the achieved result reaches the planned result (called financial loss period). The durations of the periods vary from incident to incident, but the structure of the downtime process usually follows the chart. It is not evident that the full recovery to the planned result would match the indemnity period as shown in the figure. Indemnity period refers to the time during which the financial losses of the insured will be indemnified.

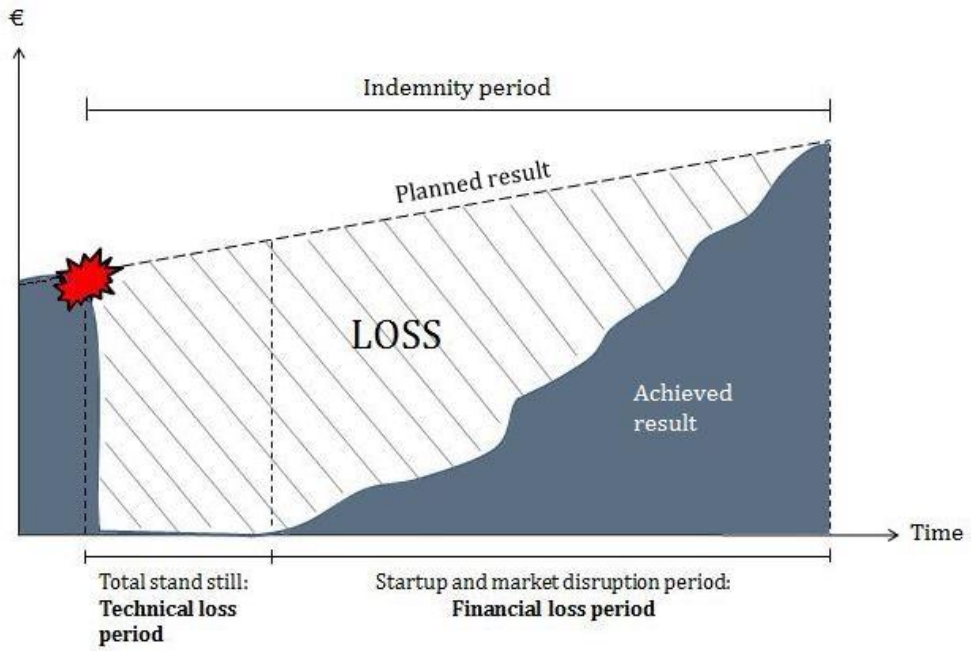


**Figure 3.2 Business interruption periods. Adapted from If Insurance P&C.**

## 3.1. Impacts of business interruptions

Business interruptions have not been studied so extensively that there would be theories and data abundantly available. Most studies related to this topic do not make research on interruptions but disruptions, which is only a decent proxy for studying interruptions as such. On the positive side, the findings from the earlier material are valuable support and give rather understated than overstated estimates on the impacts of business interruptions, because the bigger the disruption, the more likely it induces an interruption. Therefore, if the earlier research has included also those disruptions that have *not* led to interruptions, then the impacts of only those disruptions that have led to interruptions should be even greater.

### 3.1.1. Theoretical findings

Theory seems to have very few studies on pure business interruption consequences and concentrates instead on supply chain disruptions and their impacts on business. There seemed to be one model created by Lewis (2003) for analyzing operational 'pathologies' and the consequences on different stakeholders. Additionally, it was only an exploratory model with many deficiencies, which made it unsuitable for this study. According to a research made by Hendricks and Singhal (2005b) some consequences of supply network disruptions are poorer profitability (also found by Silva and Reddy (2011)) and net sales, increased costs, and negative impacts on assets and inventories. Silva and Reddy (2011) have also observed that supply chain disasters hamper fulfilling promises towards customers. Two years following the disruption the profitability, sales and asset figures are not going to be any better (Hendricks and Singhal 2005b), which highlights the importance of risk management because one disruption can restrain the growth for many years. That sort of long-term effects should make the management anxious about their resilience, but because directors are typically really interested in stock price, the following finding should wake them up at the latest. Hendricks and Singhal, namely, found out in their other study (2005a) that the average drop in stock return from one year before the announcement of the disruption to two years after the announcement is nearly 40 percent compared to comparison sample.

One topic related to this is the probability of going bankrupt after a major incident. There are several sources that give estimates about the probability of going bankrupt under specified conditions. Gosling and Hiles from Continuity Central (2009) have compiled 29 estimates mostly by economic institutions or governmental agencies that show signs of tendency to go bankrupt after a major loss. The results vary from 20 to 90 percent probability of going bankrupt depending on the conditions. There are limitations such as type of disaster, specific hazard related cases, and different timespans after the incident during which the companies fail. Nevertheless, the concerns are relevant because so many studies show at least somehow that business interruptions have negative or even terminating consequences. However, the scientific approach of those sources would be difficult to validate, and therefore there would be demand for further research on the issue to get more reliable results.

### 3.1.2. Consequences of business interruptions

Business interruptions can affect uniquely the companies because their incidents, business models and environments are unique as well. Research on business interruption consequences is limited, but the empirical part will respond to this deficit.

Stump (2010) and Glendon and Bird (2013) have found only few mutual consequences, which are loss of income, problems with customers or even loss of them, damage to reputation, and loss of compliance on regulations. Surprisingly, most of the factors were not mentioned in both lists. Stump adds that interruptions endanger the business control and the assets of the company, affects employees' moral, and increases the financial costs of the company. For example, loans become more expensive. Glendon and Bird (2013) have found out that supply chain disruptions have also impacts on working costs, service quality, product recalls and release delays, share price, stakeholders, and increase in regulation-related workloads.

The study by Glendon and Bird (2013) relates to supply chain issues, which is again a small drawback, while the material by Stump (2010) related to business interruptions, but is only a presentation, which makes the source slightly unreliable. However, Zurich, the Stump's employer, is professional organization and there should not be significant doubts on the reliability of the contents because the material was labeled with Zurich, and the

contents were not pointless. These deficits just validate the fact that this area would need additional academic research.

One real-life example is a network of small shoemakers in Kobe, Japan. After the earthquake, they saw their customers turning to their Chinese competitors and maintaining only tenth of their pre-catastrophe sales (Sheffi 2005, p. 68). The earthquake was a trigger which had permanent changes in the business environment and in this case the outcome was among the worst possible.

### 3.1.3. Statistics and findings

According to the survey by Glendon and Bird (2013), 75 percent of surveyed companies have faced a disruption within a year, and 15 percent of companies had disruption-related costs over €1 million in 2012. Even though the estimates and the setups of different surveys about business interruptions and disruptions vary from each other, there is strong evidence that disruptions have become a common nuisance for companies.

Another study by CFO Research Services (2009) shows that based on a survey with 169 large U.S. companies, 54 percent had faced at least 'some' negative financial performance over the past five years owing to logistics disruptions; 53 percent because of supply chain partner's underperformance; 45 percent because of natural disasters; and 42 to 20 percent due to physical asset failure, reputational damage, security breach or man-made disaster (see Figure 3.3). Contrariwise, the survey by Glendon and Bird (2013) finds out that over half of the disruptions related to IT or telecommunication problems, weather being the second most common source of disruptions. But because disruptions are so diverse, the frequencies and distributions vary from survey to survey depending on the participating companies and the timing of the survey.

The CFO Research Services' (2009) figures implicitly mean that probably a clear majority has faced at least some negative impacts over the past five years, because different companies can encounter different types of disruptions. If 54 percent has faced at least some financial damage because of logistics, the rest 46 percent have probably faced another kind of disruptions than related to logistics. In other words, if only logistics

disruptions alone had affected at least somewhat over a half of the companies, so how much more all eight different disruption categories have affected the surveyed companies.

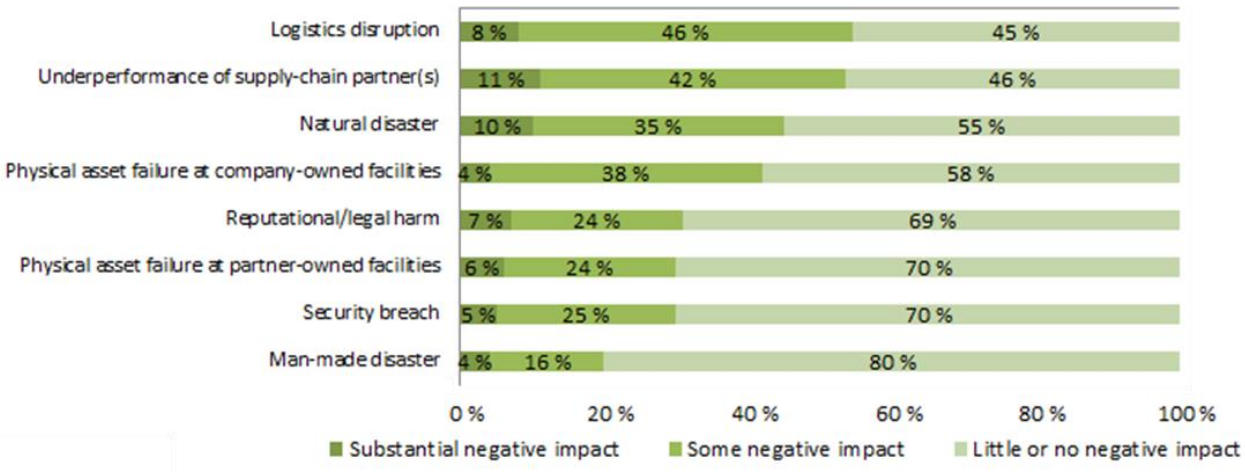


**Figure 3.3 One observed incident type distribution (CFO Research Services 2009)**

To get some estimates for probability of facing substantial or some negative financial impacts, it is roughly assumed by the writer that the historical data corresponds to the probability to face similar disruptions also in the future. Hence, the estimated probability for substantial impact would be one minus the probability of not to face substantial impacts, which is calculated as follows:

Equation 3.1 Probability of facing substantial impact

$$P_{substantial} = 1 - \prod_{k=1}^{8}(1 - p_k)$$

where k denotes the class of incident, and p the probability of substantial impact

$$1 - \big((1 - 0.08) * (1 - 0.11) * (1 - 0.1) * (1 - 0.04) * (1 - 0.07) * (1 - 0.06) * (1 - 0.05) * (1 - 0.04)\big) = 0.436 = \mathbf{44}\%$$

The estimated probability to face substantial negative financial impacts in next five years is about 44 percent. Even though this is scientifically questionable result, it gives a vicinity of the true probability.

Similarly, the estimation for at least some negative impact can be calculated so that the probability of little or no impact is subtracted from 100%.

Equation 3.2 Probability of facing at least some impact

$$P_{at\ least\ some} = 1 - \prod_{k=1}^{8}(p_k)$$

where k denotes the class of incident, and p the probability of little or no impacts

$$1 - (0.45 * 0.46 * 0.55 * 0.58 * 0.69 * 0.7 * 0.7 * 0.8) = 0.982 = \mathbf{98}\%$$

In this case, it is almost sure that a company will face at least some negative financial impact owing to one or more mentioned risks in the next five years. The figure is high because companies have many different sources for incidents, and thus, the probability to avoid them all is very slim.

## 3.2. Dependencies

The best description of dependency seen in the material is given by Hallikas *et al.* (2004), whereby they explain it to be growing as collaboration between companies deepens. Dependency is reliance on something, and the failure of the other party affects the other party as well. I concentrate on collaboration more deeply in part 5.3, but as I find out in that section collaboration has many benefits which encourage companies to expose to stronger dependencies.

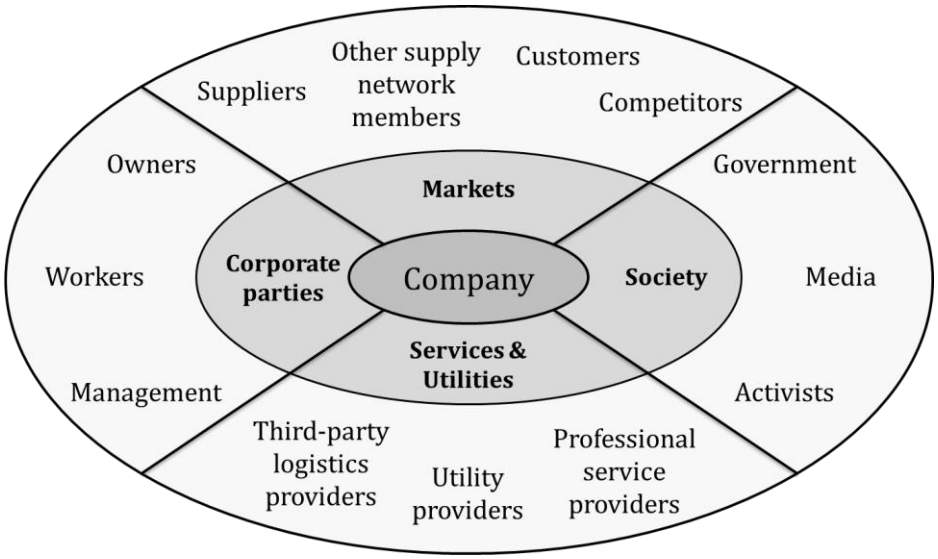


**Figure 3.4 A Stakeholder map. Modified from Freeman (2010, pp. 8-22).**

Figure 3.4 lists companies' most prominent stakeholders that include the most significant dependencies. Not each of them are dependencies for a company, but it is important to understand that companies can be severely dependent on not only their direct suppliers and customers as for supply chains, but to a number of other stakeholders on top of those.

As companies pursue efficiency, Berger and Zeng (2006) point out that in business it intensifies dependencies within the supply chain, because efficiency means reducing partners and concentrating on fewer nodes in the supply network resulting in more vulnerable supply chain. Hallikas *et al.* (2004) accompany the idea expressing that the increased dependencies between companies inevitably increase their business interruption risk owing to the risks that the other companies experience. Therefore the need for understanding of these risks, tools and concepts for managing contingent risks, as well as suitable risk management approaches should be also improved within companies and partnerships. These partnerships have become very often 'strategic' because companies rather reduce than increase their suppliers (Blome and Henke 2009, p. 125). Communication and sharing information about logistics and supply networks would mitigate not only external dependencies but also internal dependencies, because fact-based knowledge could help in mapping the critical dependencies both externally and internally (Zurich 2009). The claim that depth of the relationship corresponds to the depth of the dependency (Hallikas *et al.* 2004) means that the deepest relationships incur severe

dependencies. On the positive side, the deepest relationships are also very fruitful situations to cooperate in risk management, and therefore the effects of disruptions could be mitigated (Yang and Yang 2010). More specifically, if there are many companies in a network, the risks emanating from relationship dependencies as well as their impacts differ from company to company depending on the network structure (Hallikas *et al.* 2004). Therefore, companies should maintain their own responsibility to analyze the risk levels and impacts to which they are exposed regardless on extant cooperation in the network (ibid.).

### 3.2.1. Dependencies in practice

According to a professional risk engineer (Danilotschkin-Forsman 4.9.2013, interview), identifying critical processes and machines (i.e. dependencies on them) is very important because even small disruptions with them may have severe consequences if the problem cannot be solved in a short time frame. Many companies use unique machinery, whose replacement can take significantly time, and even though the machine could be replaced by newer, the process may need to be changed. This concern is pointed out also by Craighead *et al.* (2007) saying that the implications extend to supply chain, because replacing custom machinery and restarting the processes may take time and thus, cause disruptions to the material streams in the chain. Particularly in facilities where the fire spreads fast, the need for fire extinguishing systems is high, because the damages remain only minimal if it is suppressed right after the ignition. Therefore, Craighead *et al.* (2007) highlight the importance of warning and extinguishing systems in the supply chain's business continuity.

IT system dependencies are a pivotal risk because operations within and between companies lean on computer systems and technology. Wright (2013) highlights the concern of "system-wide" cyber risk in modern digital supply chains because links from the own system reach out to multiple external parties. In EY's Global Information Security Survey 2013 cyber risks was at the second place, and data leakage/loss prevention at the third position. In 2013, only business continuity was higher on the list. When the topic is narrowed down to information security, these mentioned issues are always important among internal or external misconduct of the information, privacy, and security standards

to mention a few. However, it would be much more interesting to compare the concerns of all sorts of threats – not only IT risks.

Sheffi (2005, p. 69) notes that disruptions may lead to unexpected business interruption to parties that are not involved with the incident due to the inability to supply or purchase by a suffered company. Hallikas *et al.* (2004), too, stress the significance to understand also the dependencies of the companies the focal company is dependent on. The fire at Philips' facility in Albuquerque was fateful not only for Ericsson who could not purchase wafers from Philips but also for Ericsson's other suppliers that could not supply the other components to Ericsson because of the lack of one critical component. So, the Albuquerque fire disrupted the operations of other partners in the Ericsson's supply network as well (Sheffi 2005, pp. 8-9).

## 3.3. Communication

One important aspect what comes to business interruption incidents is communication. It is even more important if it has to do with consumers and their safety, health, environment, or other aspects of their lives. Tylenol, an American painkiller brand by Johnson & Johnson, is a model example of good crisis communication when they had a cyanide crisis that killed seven people in 1982. According to Stateman (2008) Johnson & Johnson was successful with their crisis communication because they were open and honest, and took immediate actions after they heard the bad news. Another fact that helped them was that it was not their fault but they were rather victims of a sort of terrorism, as reporter Mitchell Leon wrote after the outburst of the crisis (ibid.). Sheffi (2005, p. 30) adds that they lost their market share and the trust of consumers, but with their dedication to improve the production processes into tamper-resistant methods coupled with effective marketing they could win back the trust and their market share, but with huge costs. It was all about communicating the concern and actions to the consumers.

Information flows very rapidly today, and the role of corporate communication to stakeholders is a key to give considered and truthful information when accident has happened. Anyone can access an immense load of information on the internet, and know more about a catastrophe before the key people related to it. In 1995, when an earthquake

hit Kobe, Japan, Texas Instruments knew about the earthquake in minutes because of the alert systems in USA, but Japanese prime minister received the information four hours later (Sheffi 2005, pp. 161-162). Sure, there were lots of hierarchy behind the delay, and some officials knew about it immediately, but it must be emphasized that people will hear about incidents sooner or later, and in corporate world customers surely prefer getting the information directly from the company – not from the news or other third parties. Therefore the responsibility and importance of communication is notable.

# 4. AVOIDING BUSINESS INTERRUPTIONS

Why do people buy insurances? It is the feeling of confidence that if something bad happens, it will not ruin everything, and thus, you are ready to pay the premium for that confidence. The same applies to business interruption risks. Loss prevention and resilience are not free at all (Christopher and Peck 2004), nor is the insurance. Still, companies are ready to pay for the premium. Many enterprises have not made notable efforts on avoiding business interruption as, for example, Mitroff and Alpaslan (2003) have studied that only 5 to 25 percent of Fortune 500 companies have a strategy for crises. The hidden costs of incidents could be partially or totally replaced by efforts on resilience and risk management practices that can prove better idea than learning from losses.

This chapter introduces firstly the concept of vulnerability and methods to reduce it. Then, business continuity plans are discussed as a way to avoid risks, mitigate them and recover faster from losses. Third part considers different sourcing processes and strategies that affect the propensity and the consequences of an incident, and the last part talks about supply chain risk management.

Business interruptions have many adverse impacts on the suffered company (see part 3.1 and framework), and thus, the reason for taking actions against business interruptions should be evident. However, companies have so much else than risks and interruptions to think about, and they try to minimize their costs, so it is probable that a company starts thinking their continuity only after they have experienced so hard a shock, which makes them open to this topic. Even though the avoidance of interruptions is not free, regrettably many companies pay the huge costs facing a disaster without preparing for it, and only then accept the risk management investments that provide them a good defence against many shocks and events. For example, Ericsson (and their insurers) paid hundreds of millions of euros only due to business interruption before they designed and implemented a new SCRM approach (Norrman and Jansson 2004). However, every cloud has a silver lining: companies tend to learn at least something from the incidents that prevent the same from happening again, mitigate the impacts of it, or benefit from the lesson in many other areas as well (Lewis 2003). The more a company has faced incidents the more it knows how they happen and what the consequences are, which can be useful knowledge while

planning better loss prevention practices. Some experiences, however, implicate that the lessons are not leading to better practices later because there might appear disputes between different functions within the company affecting the fact that the accident does not lead to better handling of the situation in the future (Toft and Reynolds 1997 cited by Lewis 2003).

The World Economic Forum (2011) emphasizes the need for *proactive* risk management approach in order to mitigate the increased impacts of the complex risks that exist in the jungle of global supply chains. Reactive methods should relate to resilience, which leads to faster recovery, but risk management as recognizing risks and preparing for them should naturally be proactive so that loss prevention would be more effective. However, resilience is not solely reactive, and therefore, resilience should be included in the risk management mindset and practices.

Before going deeper into the theory and practice about risk management, it is good to remind that risk management itself is only a tool to secure business continuity, financial stability and the flow of the business as a whole. As Norrman and Jansson (2004), and Chopra and Sodhi (2004) suggest, the use of these tools should be justified by financial calculations. Additionally, the calculations should include all costs related to build-up, usage, and updating of the risk management tools and resources as well as the hidden costs, losses incurred by risk management failures, and administrative costs – as included in total cost of risk (TCOR) models – not only the direct costs that are visible for the organizations. Christopher and Peck (2004) share the same idea saying that the definition of cost should include also the increased exposure to risks and their consequences. However, the practical problem with the implementation and adequate effort on risk management may be limited by the fact that the permission to spend resources on those activities must be accepted by the top decision makers, whose persuasion is based on expenses related to events that may never occur (Zsidisin *et al.* 2000). Risk management activities may seem unfounded for those, who are not familiar with risk management but instead, stare at the bottom line too firmly. The optimal situation would be accepting the necessary investments in risk management but on the other hand, preventing careless spending on all possible processes and every imaginable risk that would make the risk

management processes very complex and endanger the profits in the long term – albeit the amount of incidents would probably be smaller.

## 4.1. Reducing vulnerabilities

Operating environment has changed from the times when companies could afford redundancies without such concerns of reduced competitiveness from higher costs, which leads to higher prices or smaller margins. Shareholders typically cannot accept that, and companies have had to optimize and streamline their operations. Duplicates have been largely removed, and redundant processes have been outsourced. This has led to vulnerable conditions that endanger the business continuity.

Vulnerability is rather simple to understand to some extent, but each may see different sides of the concept. Therefore, it would be good to give a definition of vulnerability in this context. Asbjørnslett (2009, p. 18) gives a broad insight on vulnerability stating that it is:

> *the properties of a supply chain system; its premises, facilities, and equipment, including its human resources, human organization and all its software, hardware, and net-ware, that may weaken or limit its ability to endure threats and survive accidental events that originate both within and outside the system boundaries.*

This definition covers entities' operations and assets widely, and summarizes the idea behind vulnerability quite well. Sheffi (2005, pp. 270-279) lists seven steps for companies to reduce this vulnerability:

(1) Having plans for disruptions, catastrophes, and crises
(2) Assessing the current vulnerabilities
(3) Reducing the likelihood of events that have negative impacts on business
(4) Collaborating with external parties for security
(5) Creating flexibility and having redundancies
(6) Increasing agility and adaptability to changes and delays
(7) Investing in training and culture.

Companies desiring to get rid of vulnerabilities should neglect none of these because each has a meaningful purpose in loss prevention and risk reduction. Good preparation

beforehand is essential owing to better knowledge of risks and their impacts, and faster recovery because of prepared plans and mapped alternative solutions. A thoughtful response after a shock is always better when scenarios have been analyzed and best alternatives are already known. A regularly updated business continuity plan (BCP) is the best practice, but other kinds of plans are much more valuable than not having a plan at all.

The second and third points become much easier when the first part has been done well. A thorough understanding of the critical points in the processes is the basis for considering the worst vulnerabilities. While companies know their most important phases in the operations, and how they can be disrupted, they can put the best effort on reducing the risks related to the key processes.

As an expert of terrorism, Sheffi gives a lot of weight on security, which is nowadays more important issue also in places where terrorism has not made manifestations. Security problems can be industry-wide, which encourages companies to cooperate fighting the problem (Sheffi 2005, pp. 274-275). A good example is the International Air Transport Association (IATA), who biannually summons all "plausible" airlines to share their knowledge and experience of mistakes and near misses so that the whole industry could learn from them (Saastamoinen 2013).

Flexibility, redundancies, agility, and adaptability are all common ways to increase resilience, and each of them have different strengths that can make the disruptions' impacts smaller because they give the company more cushion and alternatives to solve the problems. These are discussed in more detail in chapter 5.

The last step is to invest in training and culture. After all, many practical things resolve with the right culture because employees understand their role and they are willing to contribute to the success of the company. If the employees have been trained well, they know how and why things are being done and they want to continue the success of the company.

There are two matrices, which give a simple structure for vulnerability. The first matrix depicts risks in terms of vulnerability, and the matrix below with the same axes is giving the strategies that suit best with each quadrant presented in the first matrix.

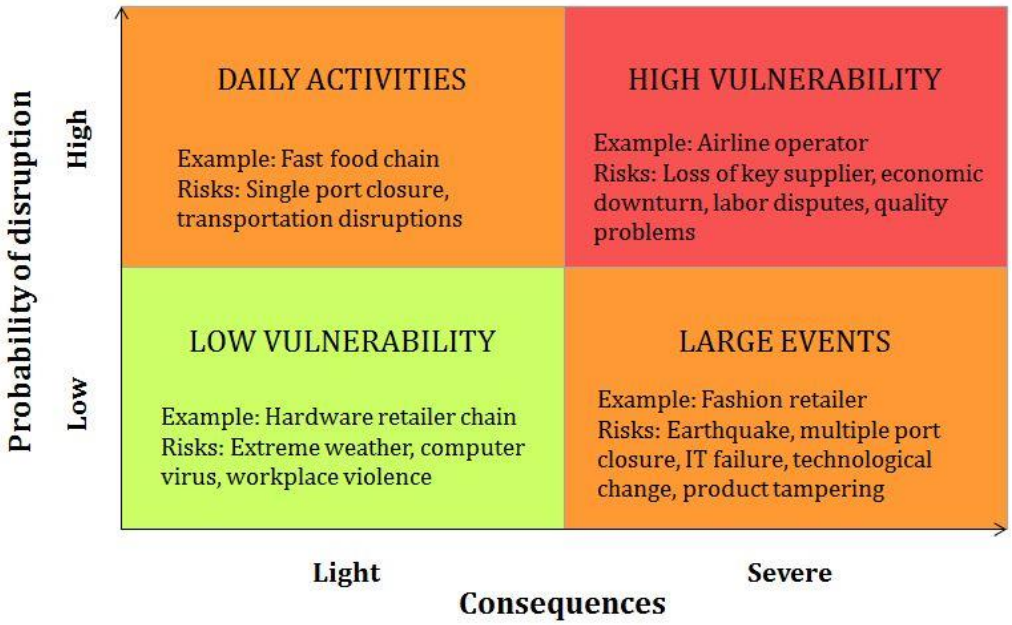


**Figure 4.1 Dimensions of vulnerability (Sheffi 2005, pp. 20, 22, 32)**

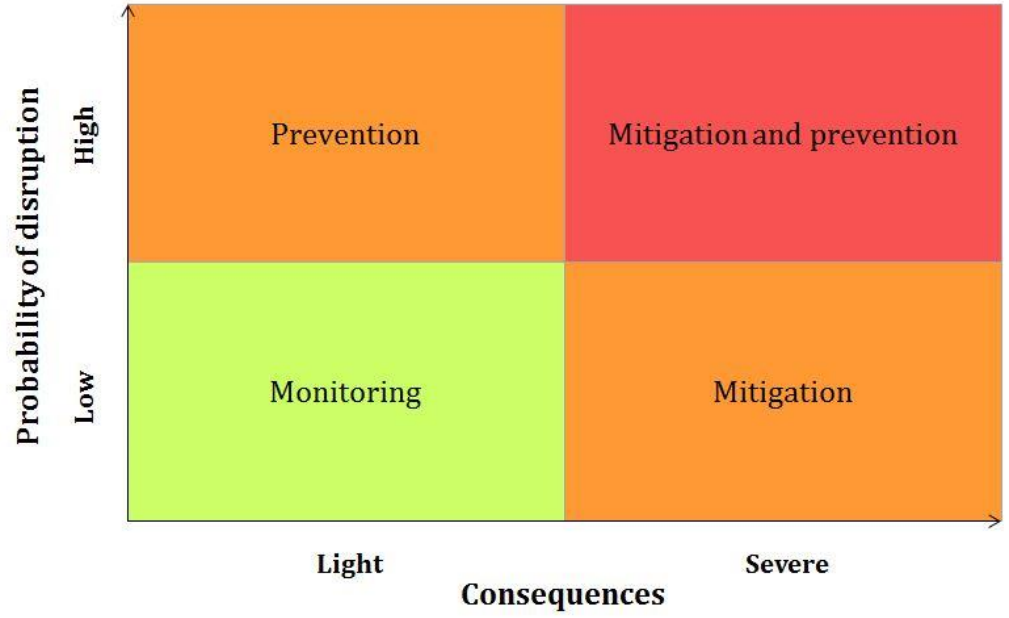


**Figure 4.2 Strategies for managing vulnerability (Del Bel Belluz 2010, p. 293)**

High-probability events are more familiar to companies because of the experience and possible statistics and analyses as well, and therefore those can be analyzed better than rare events (Sheffi 2005, p. 57). Asbjørnslett (2009, p. 32) says that ignorance of threats can

induce vulnerability, so the low-probability/high-impact risks are perhaps even more dangerous for companies because they may lack experience and knowledge of those threats.

## 4.2. Continuity planning

By definition, "business continuity is the capability of the organization to continue delivery of products or services at acceptable predefined levels following a disruptive incident" (ISO 22313 Societal security, p. vii). Cerullo and Cerullo (2004) claim that it is common for companies to have a reactive disaster contingency recovery plan (DCRP), but business continuity plan (BCP) would be more proactive and much more comprehensive. It is crucially more effective to prepare the plans before the events occur than start the process when crisis has hit and, the chaos is reigning. Castillo (2004) elaborates the difference between BCP and other plans that disaster preparedness programmes and such plans – being still helpful in recovery – do not concentrate on staying in business which is a much larger issue than single incidents that occur every now and then. While a disaster plans have the focus in the crisis, a BCP – as the name indicates – focuses on business continuity, and it calls for deep understanding of the business so that the prepared actions would really save the company from lethal strikes. A BCP has three major functions: "(1) to avoid or mitigate risks; (2) to reduce the impact of a crisis; and (3) to reduce the time to restore conditions to a state of 'business as usual'." (Cerullo and Cerullo 2004, p. 71). This definition emphasizes the importance of having it implemented, because there are so many risks bombing the companies, that being without a plan to recover from hits makes them (1) to be easier targets, (2) to be more vulnerable to hits, and (3) suffering even more because the recovery is slower (cf. the previous list).

Continuity enables the company to make profits even when disruptive events occur by withstanding the shocks. Damages happen also to the most resilient companies but knowing the reasons and consequences of the glitches and having the means of controlling the glitch helps recovering from the losses (Blackhurst *et al.* 2005). A good business continuity plan does not, however, need to be detailed step-by-step guide but a structured document which includes analyses on the most important blocks of the business – processes, suppliers, customers, people, and assets – from the revenue generation and value

creation viewpoint (Castillo 2004), and therefore it would be pure utopia to have a functioning step-by-step plan regarding all necessary points. That would require also a detailed description of the event, which is unlikely as well. Furthermore, testing of the plan is beneficial to the quality, because it may reveal deficits and it gives also confidence when the real crisis bursts out (Cerullo and Cerullo 2004).

Sheffi (2005, pp. 11-12) notes that supply networks are so complex that understanding the big picture requires significant efforts, and the disruptions can be made by random parties that nobody can expect. A good example is an excavator somewhere in Iowa, USA that disabled the Internet connection of Northwest Airlines, which handled also KLM's traffic, affecting both airlines' operations worldwide (ibid. p. 12). It is fair to assume that it was an unexpected event that, however, induced a large-scale disruption for two major airlines. Business continuity planning simply cannot consider all events that will realize certain risks but it should try to find solutions to all kinds of risks so that whatever the cause is, they have a contingency plan, be it secondary supplier, alternative transport route, backup system, inventory, redundant production line, or anything else.

Christopher and Peck (2004) allege that while threats have moved more and more outside the company, continuity planning should also follow there to consider those risks as well as possible. Their implication is that de facto solution for the problem is making strategic changes to their organization in order to create resilience. Moreover, the continuity plans should be designed to be adaptable when situations change and new information is available (Castillo 2004), which should be self-evident. Cerullo and Cerullo (2004) point out that the continuity planning should be integrated to the IT systems because companies utilize technology almost everywhere. Nowadays IT plays an irreplaceable role in business, and thus it is a central part of business continuity as well, but this study does not go deep into IT systems, because it has been already studied somewhat more than business continuity from the risk perspective.

## 4.3. Significance of production and sourcing processes

There are differences in the approaches between operations management (OM) and risk management (RM). According to Lewis (2003), operations management has a tendency to

consider the operations from the positive perspective, while risk management regards the negative factors without paying much attention to operations management principles. This claim leaves a lot of room for improvement in the field of risk management as for operations. A Deloitte research (2013) expresses that risk management has traditionally focused on operational risks, but sees that risks can now arise from unexpected sources. Del Bel Belluz (2010, p. 300) stresses that operational risk management should be integrated into the culture and operations in order to be successful. Better reconciliation of OM which is critical for the profit margins, and RM which is necessary due to the vast amount of risks could lead to more efficient methods to manage risks without sacrificing profits too much.

CFO Research Services (2009) presents the idea, that outsourcing does not outsource the risk, because the risk is then moved outside the focal company and thus, the control of the risk is reduced. Companies probably cover somehow against outsourced risks, but it should be reminded that if the outsourced operation has been moved, for example, to countries with cheap production costs and higher risks, the company may more probably suffer from that supplier's inability to deliver and its consequences, because they do not know the actual risks anymore so well and their risk management practices may be too weak to avoid the risks of the other party. Berger and Zeng (2006) even say that the risks increase due to outsourcing because of stronger dependencies on them. Adding other suppliers would mitigate the outsourced risk so that the whole operation would not be dependent on that supplier, but as the efficiency reigns, it can be financially a tough choice.

By outsourcing, the extra costs can be avoided, and each operator can benefit from the core competences. Sheffi (2005, p. 83) discusses vertical integration and its effects on business continuity by saying that the delays in production stop the revenue streams if the production is vertically integrated, because the revenues come only from the sales of the finished products. It is agreeable that the delays may affect the whole production, but disintegration is not the solution for continuous flow of revenues, or that integration is the root cause. Intuitively it would be logical to say that by outsourcing (or disintegrating) the alternative suppliers can supply the lack of parts, but surely companies can also have many *internal* suppliers, i.e. alternative plants or production lines that can supply the lack of parts when the primary source cannot deliver the production to the next stages. This is not

a question of integration or disintegration but the production and process design. The problems can appear both in completely integrated production or extremely outsourced production, and the solutions to avoid delays (e.g. flexibility in production) can be applied both internally and externally. However, vertical integration and outsourcing both have pros and cons, so this is only about bringing up another aspect of the problems of vertical integration. After all, it must be admitted that outsourcing is easier and probably cheaper to manage, but the drawback is that possible deficiencies in cooperation and sufficient flow of information are threats to the efficiency of the supply chain.

Dual sourcing is suggested by many researches (e.g. Hofmann and Greenwald 2005; Kleindorfer and Saad 2005, and Sheffi 2001) for better supply strategy than single sourcing because single source is more likely disrupted than two or more at the same time. However, Silva and Reddy (2011) remind that there are two specific cases when dual sourcing may not be as wise as other risk mitigation strategies: they are (1) when carrying an inventory is cheaper than supplying from a 'redundant' supplier, or (2) when all suppliers rely on the same sub-supplier. In the latter case, an accident to sub-supplier could have impacts for all suppliers, which would not differ much from single sourcing situation. Sheffi (2005, p. 221), additionally, listed circumstances where *single* sourcing could be *feasible*, saying that (i) suppliers located closely may be affected by the same regional events, (ii) having several suppliers means that our status as suppliers' customer deteriorates because of smaller quantities ordered, and they will prioritize their own priority customers first, and (iii) dependencies exist widely even between companies that are not directly related, so many suppliers could be vulnerable as well. It is doubtful that these factors make single sourcing equally safe as multiple sourcing, but there are, still, good points to consider.

Sheffi's (2005, p. 215) point of view is that supplier strategies depend mainly on the depth of the supplier relationship. Having several deep relationships with suppliers would be very costly, and on the other hand having only one supplier without strong relationship is risky. The equilibrium is twofold: either many shallow supplier relationships or one strong (see Figure 4.3). Single sourcing is more reliable because of fewer parties that can encounter an incident, but the impact of single supplier's problems become greater than having alternative suppliers (Blome and Henke 2009, p. 132). Sheffi makes the matrix

simple, but it could take also e.g. the flexibility, production process design, costs and resilience of the supplier into account because relying on one supplier and simultaneously being able to supply the demanded amounts of parts and products requires persistence towards disruptions, shocks, delays etc. no matter how deep and good the relationship was.

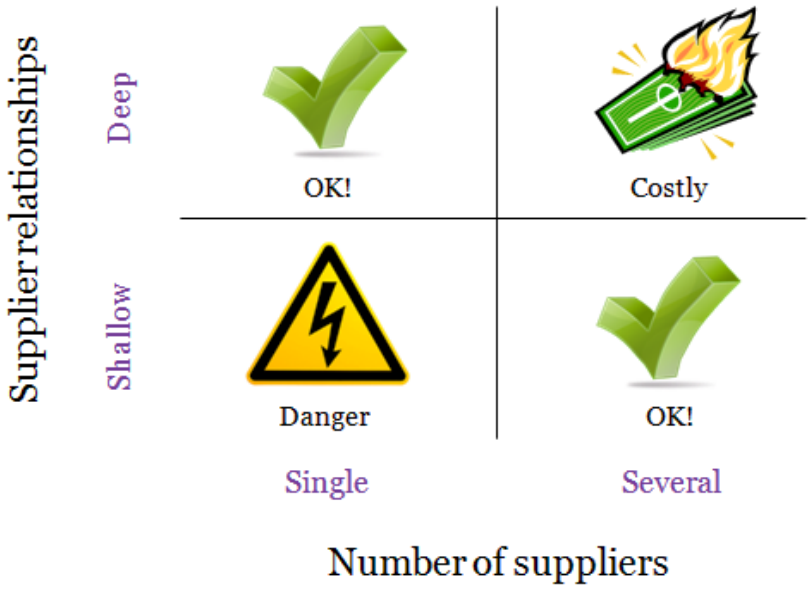


**Figure 4.3 Supplier relationship matrix (Sheffi 2005, p. 215)**

**Table 4.1 Advantages of single and multiple sourcing. Modified from Blome and Henke (2009, p. 127).**

| Single sourcing advantages | Multiple sourcing advantages |
|---|---|
| Cost reduction through bundling and standardization | Lower prices owing to higher competition |
| Status of being more important customer for supplier than having several suppliers | Lower dependencies on suppliers |
| Less suppliers, less complexity | Lower dependencies on single technologies |
| Lower transaction costs | Ability to change suppliers flexibly |
| Easier quality assurance | |

Blome and Henke (2009, p. 127) have collected advantages of different sourcing strategies. I have chosen the most important pros of single and multiple sourcing into the table above.

The table shows that both strategies have very good advantages, and even though they are not perfectly mutually exclusive, acquiring benefits from both strategies seem rather exceptional. As we can see, the choice of the strategy affects widely with respect to business and risks, such as costs, competitive situation, dependencies, and complexity. Leaving these aspects out of the strategy creation decision-making can be detrimental for the business as a whole, because sourcing usually generates a large share of production companies' expenses. Tang (2006b) reminds that upgrading the strategies might not improve the business impact unless they are aligned with business model and practices. Blome and Henke (2009, p. 132) make a good note that multiple sourcing may include more risks related to availability of material as thought, because dividing the demand for many suppliers may lead to situation where the buying company is very minor customer for each supplier. In case the suppliers could not deliver the orders, they very likely prioritize the biggest customers. On the other hand, if the suppliers are dispersed, it is rare that many suppliers are down simultaneously. Maybe industry-wide events or a shortage of raw materials could render such situations. Yang and Yang (2010), however, allege that single sourcing is so dependent on one supplier that multiple sourcing would be the safe choice. After all, finding a right and functioning supplier base is important so that the risks and sourcing costs would stay reasonable without endangering the business continuity of the company (Berger and Zeng 2006).

## 4.4. Supply chain risk management

An increasing headache in supply chain risk management (SCRM) is the use of lean strategies. It makes the participants of the supply chain vulnerable because redundancies have been eliminated (e.g. Silva and Reddy 2011). Bartholomew (2006) adds that such lean strategies bind companies to the plans and do not provide room for surprises. When a disruption occurs there is little to do when capacity is well utilized and inventories are minimal. The application of global supply chains have increased owing to the search of cost-efficient sourcing and production. This leads inevitably to more shipments and longer distances. Thus, the product sourced from the local manufacturer is far less exposed to risks than the product that has travelled across the "seven seas" during its production and

assembly process (Itkonen 2013). Chopra and Sodhi (2004) assume that finding the balance between supply chain risks and profits is the biggest challenge for managers.

SCRM does not have an unambiguous definition but Wieland and Wallenburg (2012, pp. 890-891) have combined views from the studies by Jüttner *et al.* (2003), Tang (2006a), and Manuj and Mentzer (2008) to develop their definition of SCRM as follows: "Implementation of strategies to manage both everyday and exceptional risks along the supply chain based on continuous risk assessment with the objective of reducing vulnerability and ensuring continuity." This definition fits well with the chapter because there are several common elements.

Different studies brutally show that the majority of the companies do not apply any mitigation strategies for supply disruptions. Tomlin (2006) states that companies generally do not pay adequately attention to their strategies, which can lead to insufficient control of their risks. Companies are concerned of their vulnerability according to Aberdeen Group, which has studied that 82 percent of companies are concerned about supply chain disruptions but only 11 percent take actions (Silva and Reddy 2011). Remembering the unanimous opinion within the research material that the risks in supply chains are increasing due to globalization, cost reduction and shorter lead times, these are very worrying figures. Although a comparison of the results of many different surveys would validate the findings better, these figures are showing that a negligent attitude towards risks might be a serious threat for companies. Furthermore, while the networks become more and more complex and companies more dependent on each other it is good to remember that even though your own part would have been done well, the supply chain is only as strong as its weakest link (Christopher and Peck 2004). Now that most of the surveyed companies in different researches actually do not seem having done their own part so well, we can ask whether the supply chains are performing reliably.

Risk assessment is a central part of SCRM, and therefore it requires efforts to be successful. Supply chain risk assessment table lists some important points about risk assessment about what is necessary and helpful when doing it (see Table 4.2). The requirements are more important than additional considerations because without proper tools or resources granted by management the results remain probably lame. When the

objective is to make the assessment brilliant, it can take also many additional factors into consideration so that the results and findings would be more useful for the company. The table shortlists some benefits, which follow when it has been done properly.

**Table 4.2 Elements of supply chain risk assessment (Wildgoose *et al.* 2012, pp. 59-60)**

| Requirements | Additional considerations | Benefits |
|---|---|---|
| Support from top management | Information flows | Hints on (over)reliance on each supplier |
| Suitable tools and skills | Infrastructure | Pinpoints the weaknesses of supply chain |
| Risk assessment experience | Networks between organizations | Shows risks that the supply chain is exposed |
| Supplier interdependence mapping | Macro-level factors | |
| Mitigation solutions | | |

Mitigation activities will naturally decrease the costs related to disruptions, be it material costs, lost reputation, obligations to customers, share price, or other costs that are induced by a loss, albeit risk management practices evidently increase costs as well. Wright (2013) also sees that risk management and efficiency are not mutually exclusive options but rather causal in such way that risk management can diminish the impact of the high-probability risks that incur continuously losses that nibble profits. It should be remembered that risk management can even increase efficiency, when, say, excessive complexity is reduced. Wildgoose *et al.* (2012) emphasize that the risk assessment should not include only costs, but also take the other aspects and impacts of accidents into consideration.

Wildgoose *et al.* (2012) encourage to do a thorough due diligence on critical suppliers because knowing the impacts of a disruption and being able to respond to them can help in surviving from an event much faster. If a supplier is ‘critical’ then the impacts of disruptions follow accordingly for the focal company, and hence the wide analyses and in-depth risk assessments including site visits are strongly recommended. The best concept related to this problem is business impact analysis (BIA), which maps the business model and the impacts of changes in critical components of the business in detail (Cerullo and Cerullo 2004, and Wildgoose *et al.* 2012). Having a BIA a company is quite well prepared for encountering events that have impacts on income or any element of the company, because they have a better understanding of the business, and the risks they are exposed to.

# 5. BECOMING RESILIENT

> *To cope with these vulnerabilities one must make the logistics and supply chain system resilient.* (Asbjørnslett 2009, p. 22)

The chapter starts with definitions and introduction to the topic. They are followed by a simple model, which manifests a concrete way to increase resilience in a company. The following parts present building blocks of resilience, and in the end, the significance of resilience is concluded.

Since resilience is rarely the fundamental objective of a company or supply chain, it makes the creation of resilience more difficult than it could be if other aspects of conducting business could be disregarded (Christopher and Peck 2004). However, they claim that it has its benefits, and the way of gaining it starts from understanding the supply network, its bottlenecks and other critical "pinch points".

Pettit *et al.* (2010) present the idea of matching vulnerabilities with capabilities so that the balance between risks and costs would be optimal. If the vulnerabilities exceed or do not match the capabilities with which the vulnerabilities would be managed, the exposure to risks may endanger the business. On the other hand, if the capabilities prevent the company not only from the actual risks but also from risks that are not relevant for the business, the costs incurred from maintaining the capabilities are just eroding the potential profits. Hence, the balance should be found to optimize the risks and profits. The authors make a valid point in their later article reminding that the 'excessive' capabilities from the resilience point of view may be vital from other business perspectives, and therefore the those capabilities should not be seen only as factors eroding profits (Pettit *et al.* 2013).

**Table 5.1 Vulnerabilities and capabilities (Pettit *et al.* 2010, pp. 11-12)**

| Vulnerabilities | Capabilities |
|---|---|
| Environment turbulences by external factors | Sourcing flexibility |
| Deliberate threats | Order fulfilment flexibility |
| External pressures that limit businesses | Asset capacity |
| Resource limits from unavailability of resources | Production efficiency |
| Product or process sensitivity for conditions | Visibility of asset status |
| Connectivity and dependencies | Adaptability |
| Supplier/customer disruptions | Anticipation of events |
| | Recovery from anomalies |
| | Asset dispersion |
| | Collaboration |
| | Organizational capabilities |
| | Market position |
| | Security |
| | Financial strength |

This approach is only one method to tackle the vulnerabilities, which is not perfect but a good one. Asbjørnslett (2009, p. 18) has observed different vulnerabilities such as technical failures, accidents, and loss of key personnel that do not clearly fall under the categorization by Pettit *et al.* Asbjørnslett's vulnerabilities, however, are slightly different because they are more specific risks, which could be sub-factors for the Pettit's *et al.* list. Hence, the more general categorization describes better the word 'vulnerability' because it is more like a condition than a specific threat from a certain hazard.

## 5.1. Defining resilience

Wright (2013) defines resilience as "capacity to adapt" rather than as fixed strategies because the conditions to conduct the business change due course. A suitable level of resilience in certain conditions can be adequate, but changes in operating environment or perhaps in the structure and locations of plants can call for changes to resilience strategies.

The expansion of supply chains into the global context has extended the risk variety to such heights that companies can prepare for only some portion of the existing risks (Deloitte 2013). Therefore, they suggest that a solution for this vulnerability is to create

resilience, which takes a proactive approach to managing the increasing exposure to threats.

Even though the contents of this chapter could be presented in the previous chapter as well, the major reason for separating these two is that "resilience is an evolving concept and differs from traditional risk management" (Pettit *et al.* 2010, p. 4) and therefore this chapter concentrates on the core of resilience, which is, however, one part of the risk management practices. The concept is not only evolving, but its contents seem to be vague. Researchers perceive it differently, and approach the concept from different aspects. Braes and Brooks (2011, p. 123) conclude their observations about resilience as follows: "resilience has become a widely used term by consultants, managers, bureaucrats and politicians, resulting in a catch-all terminology developing from efforts to encapsulate a complex multidimensional and multifunctional concept under a single banner." Quite similarly, Peck's (2005) first definition was that resilience is so wide concept that risk management, SCM, and continuity planning even combined do not reach that level. It was much said, because resilience is, however, one part of enterprise risk management addressing especially to the risks that cannot be expected, and giving the company ability to endure surprises. Peck (2006) defined resilience again a year later supporting the narrower definition by explaining the term so that resilience does not even try to prevent all risks but gives companies the capability to mitigate the impacts and get back to business sooner.

Traditional risk management is rarely capable of managing all risks anymore, because an increase in risks increase also unforeseeable risks that only resilience can respond. Resilience does not address to specific risks but rather specific vulnerabilities, and thus, it is the ability to prevent and recover from *many* kinds of events (Pettit *et al.* 2010).

Resilience can be defined also as the capability to recover back to the same shape as before the shock. Asbjørnslett (2009, p. 19) makes a difference between resilience, which is the ability to recover after the event and find a *new* balance, and robustness, which is the capability to resist shocks and take the *same* shape again. In the literature, there are both 'schools' of resilience represented – the school with narrow view, and the one including both 'robustness' and 'resilience' – but this study uses the term resilience by the wider

definition. The reason is that the researchers have usually not defined resilience in much detail, and therefore it is hard to find it semantically reasonable to make conclusions from the hypernyms (more general level) and claim that they represent the actual essence of the hyponyms (more detailed level) if the researchers have not considered the concept in such detailed way. Moreover, resilience helps companies also to *avoid* losses, for example by good organization culture and collaboration, which are discussed later in this chapter.

**A model for building resilience**

Acquiring resilience calls for careful planning and systematic process so that the necessary stages would be done properly and in consistent order. Careless planning could end up in such resilience, which is not so necessary for the company, and which only increases the costs but does not have the desired impact on the ability to bounce back and even prevent losses. Deloitte (2013) has made a supply chain resilience building model, but because the contents of the model are so general, it can be also applied to areas other than supply chain without hesitation. There are surely plenty of other models that could be used here as well and this is not the one and only model that can be applied. This one consists of five steps and it is an on-going process.

Figure 5.1 presents the steps as a circular process starting from current resilience assessment. In this phase, the most critical vulnerabilities should be assessed. Second step is to rank risks based on their criticality in terms of their vulnerability, and importance in operations. Third step consists of finding the right strategies to mitigate the risks and finding a balance between costs, benefits, and risk tolerance. Fourth step is to create a path to follow and to define how to improve resilience as opportunities arise. Fifth step is monitoring, observing new vulnerabilities, and preparing for the next round. (Deloitte 2013) The model is not the most organized one to apply, but it has the flexibility to be used in many circumstances. It has the necessary steps but nothing more. Therefore, those who want to conduct this process more thoroughly can add phases that specify these processes in more detail and, for example, analyze the vulnerabilities and capabilities and evaluate the balance between them and the costs as Pettit *et al.* (2010) encourage.


**Figure 5.1 Resilience process cycle (Deloitte 2013)**

The study made by Christopher and Peck (2004) lists four general principles of resilient supply chain: (1) whatever the methods for obtaining resilience are, they should be *designed into* the operations and supply chain (see 5.2 Redundancies); (2) sufficient risk identification and management requires deep *collaboration* between supply chain partners; (3) responding to unpredictable events calls for *agility*; and (4) building the *culture* of resilience. These factors followed by complexity and the significance of resilience will be discussed in the next parts.

## 5.2. Redundancies

Defining the adoption of resilience building blocks depends on the costs that the different elements take. Sheffi (2005, pp. 178-179) says that the more there is at stake, the more costs should be allowed. Some redundancy may be a "necessary evil" that gives the company an adequate safety zone before it turns into a disaster (ibid. p. 179). A good cost-benefit-analysis should be completed to know how much to have redundancy. Tang (2006b), however, brings up that measuring the costs and benefits of redundancies is a challenge, because concepts like vulnerability and competitiveness are difficult to quantify.

Nevertheless, doing even rough estimates can be informative for companies, which are pondering their levels of redundancies.

Inventories are a common way to add redundancy. But it ties capital and is expensive because you need inventory management, technology, space, people, and so forth to control and move it. The products can also become obsolete, worse or out-dated in the inventory, but with uncertainty in demand, inventory is an easy way to flatten the fluctuation (Chopra and Sodhi 2004). A common argument against inventories is that it hides manufacturing problems because the buffers cushion the problems inside. Without buffers, however, every disruption would halt the production and lead to lost sales and customer dissatisfaction (Sheffi 2005, pp. 172-173).

Capacity can be held available for fulfilling critical demand and unexpected orders. But it is expensive, and workforce has to maintain the skills and knowledge of using it (Sheffi 2005, p. 175). Extra capacity is not as straightforward as inventories because capacity in production usually needs different setups for different products, and in addition to workforce capability, there may be totally different material and component requirements that limit the flexibility of the capacity: there must be inventory of needed components and other resources, e.g. capable workforce to change the setups and operate the machines adequately. Extra capacity is redundant if other requirements limit the use of it.

Christopher and Peck (2004) continue that the source of resilience should be defined, be it flexibility or different forms of redundancies. They claim that capacity would be more flexible than inventory, but Chopra and Sodhi (2004) object saying that capacity is rather a long-term strategic decision because adding capacity takes time to be implemented, whereas changing the level and content of inventories is an easier process. Nevertheless, capacity is more flexible ex post, when the capacity has already been added.

Blackhurst *et al.* (2005) raise an issue of capacity in the discovery of disruptions. Capacity is not only bounding the production but also transportation. Major ports are a concern due to their tendency to get saturated and congested, which may cause delays in deliveries. Therefore, companies should also consider optional routes and modes of transportation.

Da Silveira (2006) addresses that applying flexibility and buffers in operations may deteriorate financial performance in the long term. FedEx has challenged this opinion by applying "shadow flights", which work as redundant capacity helping if something goes wrong somewhere; there are several empty flights every night available if extra capacity is needed (Sheffi 2005, p. 176). The managers know for sure that such redundancies incur somewhat extra costs due to employee costs as well as petroleum and increased need for maintenance and so on, but they have made a conscious decision to accept the increased costs in order to be responsive when disruptions happen. This is at the core of resilience. The losses could be much higher without the capacity available every night, and this must be told to investors very clearly and credibly so that they accept that costs are consciously increased in order to decrease the possible bigger losses.

IT systems are all in all for some businesses, and having a spare system and duplicates is a necessary backup. Losing a whole business would be too hard a shock, so a spare system is relatively cheap compared to a massive loss (Sheffi 2005, pp. 177-178). Perrow (1999) claims that systems with tight coupling (i.e. mutual interdependence on other parts of the system) can have very wide range of causes of disruptions, but *redundancies* in information systems, in particular, are the best way only to enable the destruction by hackers, evil employees, cyber terrorists and so forth. His statement is that add-on safety methods just increase the risk of accidents (Perrow 1999). The better way to design systems is that redundancies are minimized and all methods for safety have been taken into the design of the system in advance so that there would not be demand for add-on safety gadgets that could lead the villains into the system (ibid.). However, it is crucial to distinguish the differences between redundancies in operations and systems. Production operations need redundancies to tolerate shocks in the operations, while IT systems provide information that must be secured from outsiders. The redundancies of production – such as inventories or excess capacity – do not cause threat for the system similarly as weaker points in information systems. Therefore, redundancies should not be considered the same in different contexts. In operations the focus should be in resilience and financial impact of the redundancies including the possible negative impacts of the disruptions if redundancies have been limited to minimal. As said, redundancies in IT systems should be thought carefully whether or not they are necessary. Redundancies, however, are a

strategic piece of operations and they should be designed into the system similarly as the other parts of the resilient operations.

Flexibility, in turn, is rather a strategic and cooperative approach, which is more difficult to set up but which can create good resilience (Sheffi 2005, p. 179). Intel has a flexibility mindset where it has made all its plants the same so that the processes can be continued anywhere if something goes wrong in one facility (ibid. pp. 183-184). In this case the flexibility is not about the process itself but about the structure of the capacity. As Tang (2006b) suggests, flexibility can be obtained by postponement, large supply base or make-and-buy arrangements, and using alternative transportation methods.

## 5.3. Collaboration

Collaboration is discussed in many articles as a source of competitiveness and better supply chain performance. Hallikas *et al.* (2004) state that the reason to cooperate is to gain benefits for all parties involved. Wright (2013) strongly recommends businesses to cooperate throughout the society and business environment, and encourages cooperation within and between corporations because the risks affect the whole system due to the tight links between operators. However, some links are stronger and some links weaker, depending on the depth of the relationship (Hallikas *et al.* 2004). It should also be reminded that the relationships might be fruitless if the benefits are not clear. Useless exchange of information can expose the companies only to information security threats and misuse of the information. Therefore, a mutual understanding of the benefits of the collaboration can lead to meaningful and worthwhile cooperation.

Bello and Bovell (2012) say that successful cooperation helps organizations to manage risks and risk management processes better and more proactively. As supply chains are very dependent on the other partners in the network the significance of cooperation is definitely rising in order to better manage risks and business overall. Managing business is certainly not all about ‘hard’ factors, such as operations, systems and technology, but also ‘soft’ properties such as the behaviour towards other entities and willingness to cooperate that help the organization to achieve their ‘hard’ objectives (Rosas *et al.* 2011). Collaboration provides more information for all participants than companies would get

without cooperation. The information is probably also faster available, better and more relevant than without the collaboration, and as the process generates value for some parties, the value should be shared between the parties in order to encourage conducting the collaborative activities to greater extent (Bello and Bovell 2012).

As the collaboration develops, partners will share proactively information to others and thus, the potential disruptions can be prevented (ibid.). Glendon and Bird (2013) revealed that in 2012 even 42 percent of the supply chain incidents originated beyond tier 1. Therefore better communication and collaboration throughout the supply chain could improve the whole supply chain's performance. Hence, collaboration is really useful in terms of resilience and risk management. It provides a competitive edge if the whole supply chain will be informed about hazards and the supply chain as a whole can take preventive or corrective actions and adapt to new situations quicker. Early warning systems could be integrated in the supply chain to encompass all critical members of it, and hence it could limit the losses for the members of the supply chain. However, there are difficulties to get early warnings work because it seems to be difficult enough to be implemented well even within a single organization, because managers need to judge the alerts and do accordingly, and misjudgements will always lead to extra costs and inefficiency (Sheffi 2005, p. 164).

Information on orders, batch-sizes, forecasts and everything related to demand and the flow of materials throughout the supply chain can decrease the "bullwhip effect" (Chopra and Sodhi 2004). Bullwhip effect is typically inducing large fluctuations upstream even though the end-user demand would be rather stable. There are several reasons for that, for example lot-sizing optimization, lead-time variation, and demand uncertainty. Those consequences could mostly be avoided if the whole supply chain would collaborate effectively minimizing the total costs of the supply chain. Often times the supply chains are, however, so complicated and intertwined that the deep collaboration and optimization is nearly impossible to implement, and thus, the bullwhip effect may occur regardless of the willingness to cooperate.

Norrman and Jansson (2004) emphasize open discussion within the supply chain in all stages of risk management processes as well as in incident handling, which has proved

reduced effects of disruptions and smaller insurance costs. When the right information moves through the partners and is available when needed, it helps the activities with insurers, which can speed up the recovery process and eventually minimize the total losses. Christopher and Peck (2004) agree reminding that because vulnerability is a supply chain-wide concept, its management – including discussion and information sharing – should also be supply chain-wide, without forgetting the internal vulnerabilities, though. Risk management cooperation has potential for improving financial performance because exchange of information and methods may help others to see points that have not been thought at other companies. Secondly, it may reduce the likelihood to be involved in accidents which also reduces losses, and can give them opportunities to grow when they remain strong while others shake (Sheffi 2005, pp. 284-285).

Collaboration also aids in the global supply chains where the lack of visibility can be more challenging problem (Bello and Bovell 2012). The interviews by Blackhurst *et al.* (2005) made them see that visibility is among the key worries in the companies after each of their respondents raised it as one of the most concerning topics. Therefore, they suggest that relevant information should be available for every participant in order to be able to respond quickly to changes and avoid disruptions (ibid.). Hallikas *et al.* (2004) present that information is not the only thing to exchange; visions and opinions could also be exchanged but the danger with them is that assumptions can be overstated or underestimated. Christopher and Peck (2004) note that the lack of mutual communication and information on demand leaves the supply chain to remain "forecast-driven" instead of "demand-driven", which adds not only uncertainty and costs because of the lack of market demand information, but also vulnerability. However, Blackhurst *et al.* (2005) conclude that the need for further research exists because there are still questions whether the benefits of visibility exceed its costs.

Many studies suggest that good supplier and customer relationships would help in loss prevention, forecasting, risk management and so on (e.g. Bello and Bovell 2012, Chopra and Sodhi 2004, and Lee 2004). It is no wonder, because the same rules apply with human relationships, and supply chain relationships are executed by humans. Toyota, for instance, could have lost much more than they did, but the cooperation with their partner Aisin Seiki right after the incident was the key factor that limited the losses (Sheffi 2005, pp. 212-214).

## 5.4. Agility

Agility in brief means the capability to adapt to changes in the operating environment, but the concept raises contradictions among researchers. Blackhurst *et al.* (2005) claim that agility – coupled with response time and inventory level reduction - would make disruptions' impacts more severe whereas Lee (2004) states that agile supply chains can respond quickly to changes, and when disruptions occur, agility helps in recovery. Their statements are not exactly the opposite, but they have pretty much contradicting insights. The viewpoint of Wright (2013) is similar to Lee's (2004) point of view that supply chains should be adaptable and agile in order to match the external conditions.

### 5.4.1. Principles of agility

Lee (2004) and Sheffi (2005, pp. 14-15) have listed requirements and principles of agility, but they consist of different building blocks (see Table 5.2). Lee seems to take a wider overview of agility while Sheffi focuses mostly on operational strategies that fit best to agile strategy.

**Table 5.2 Principles of agility by Lee (2004) and Sheffi (2005)**

| Lee (2004) | Sheffi (2005) |
|---|---|
| Sharing information with suppliers and customers | Having redundancies |
| Establishing collaborative relationships with suppliers | Postponing the customization of the base product |
| Creating structures that enable and support postponement | Having a modular product design |
| Keeping an inventory of important but inexpensive components | Standardizing parts and components |
| Having a trustworthy logistics system or provider(s) | Flexible contracts with suppliers |
| Creating plans and teams for continuity and crisis management | |

As we can see from Lee's list, agility relates deeply with collaboration because fast reactions cannot be gained without knowledge of others, and that knowledge derives from

cooperation and information sharing. Agility calls for certain strategy, and the costs from having inventories and 'redundant' suppliers must be accepted. Sheffi emphasizes the significance of redundancies, too. However, getting them is challenging because redundancies, in particular, mean inefficiencies and increased costs. Another principle that both brought up relates to postponement; the supply chain should support the chance to customize the products according to the end-user preferences at the last possible point so that the demand imbalances could be levelled accurately. Moreover, keeping inventories is always good for agility and resilience, but due to aspirations reducing working capital, having at least the most important components at hand is critical. Standardization of parts makes the storing of parts easier because the fewer varieties there are the easier it is to forecast the right levels. Without functioning and reliable logistics agility would not be what it should be. Production economy is, after all, about moving physical goods from the raw materials and production to assembly, shelves, end-users, and disposal. Ensuring the smooth and trustworthy flow of goods is one pillar of agility. The contracts with suppliers should be flexible to allow variable quantities and delivery times to meet the exact demand of the end-users. Fixed long-term contracts do not help in getting agile and being able to adapt to new situations. Agility is also ability to react quickly to disruptions, and therefore, prepared plans help companies to make necessary actions and changes so that business could be continued normally quickly.

Implementing agility requires structural and operational properties that enable faster reaction and flexible operations. The organization structure should avoid "functional silos" but instead, be interactive; suppliers should be agile as well; and the processes should be simple, flexible, and parallelized (Christopher and Peck 2004). These are not probably easy to change because what comes to reducing complexity, it will change the production processes, and as for flexibility replacing economies of scale probably would mean changing the strategy - maybe vision and culture as well so that they would be in line with the operating principles and organizational goals.

### 5.4.2. Responsiveness

If demand is very uncertain, responsive supply chain can relieve the costs that arise from stock outs and excess inventories (e.g. Sheffi 2005, p. 93). Both positive and negative

differences between forecast and actual demand can be costly. Having too large inventories incurs holding costs, and includes a risk of obsolescence and price markdowns. Too little stocks mean that products could have been sold more which does not itself incur direct costs, but leaves customers unhappy and might incur many kinds of indirect costs as well as leaves managers dissatisfied because of lost profits. Fisher (1997) has made a meritorious study on supply chain strategies, and he stresses that the supply chain strategy should match with the product type. If the product is 'functional', which means a product that has stable demand and long product-life-cycle, the supply chain should be cost effective. If the product is 'innovative' with lots of variations, shorter life-cycle, and higher margin, the supply chain should be responsive so that the costs related to stock outs or discount sales would be minimized. A mismatch between these two determinants will probably lead to extra costs and poorer performance.

Responsiveness is one type of resilience because a company can adapt faster to the new (unpredicted) situations (Sheffi 2005, pp. 97-98). Multiple sourcing is a good way to be responsive. Hewlett-Packard (HP) has a plant in Singapore for the demand that is 'for sure' on the market, while a plant in Vancouver is highly flexible responding to the uncertain part of the demand close to the market; demand is hence divided into certain quota and uncertain quota for which they have separate suppliers (ibid. pp. 99-100).

Cisco has *capacity* in US for high-end products in order to respond to demand if necessary. Simultaneously, they have *inventories* of inexpensive products produced in low-cost sites to respond to the high-demand items. Concomitantly, they can better manage their risks of delays by having some inventories and some capacity (Chopra and Sodhi 2004). Depending on the product properties, some techniques for responsiveness are more suitable than others. Holding inventory suits best for products that are not prone to obsolescence, whereas more demanding products in terms of preservation may not be easy or cheap to store which makes redundant suppliers a better strategy to rely on (ibid.).

After all, agility is not a technological but managerial matter, and cannot be gained with the efficiency mindset because economies of scale and low-cost production strategies can hardly support the requirements of agile supply chains (Lee 2004).

## 5.5. Corporate culture

Culture is common to resilient companies, and it makes them to find solutions to disruptions so that they can minimize the losses (Sheffi 2005, pp. 243-244). Lengnick-Hall and Beck (2005) have even dared to say that resilient companies do not only survive better when adverse events arise but can also thrive amidst challenging circumstances. It is questionable whether a company can even prosper during different hardships related to other than environment, because the study concerned only environmental change. But in general, the faster ability to recover may give resilient companies possibilities to take advantage from other stumbling companies. Sheffi (2005, p. 244) emphasizes the fact that corporate culture means simply the way of doing business and the principles that steer the actions – not only in disruptions but also in everyday work. Otherwise the culture would only be culture of recovering from crises if it would not be a matter of normal routines. Sutcliffe and Vogus (2003, p. 95) add that resilience is not a complex process but arises from ordinary activities that support the growth and competitiveness of the company.

Christopher and Peck (2004) remind that similarly as total quality management (TQM) has to be a matter of everyone in the company, risk management requires the interest and motivation from the top management before it has the ability to be rooted into the organization. It is absolutely necessary that the risk management culture is understood and practiced by all employees everyday so that risks in the operations could be minimized. In large organizations it may take quite long to cultivate the right culture until it becomes the norm. Sheffi (2005, p. 262) believes that resilience can be added by good culture because when employees want to do their own part well, they try to reach the objectives of the company and succeed in every way. It can be a truly challenging task, but surely worth it. Good culture reduces vulnerability and encourages better problem solving that lead to competitive advantage, referring to Nokia and the damaged plant of Philips in Albuquerque in 2000 (ibid. pp. 3-10). Additionally, a study by FERMA (2012) shows that good risk management contributes to the enterprise's financial performance. However, it is important to distinguish the impacts between actual culture and risk management efforts, because successful activities of risk management may have an effect, but having a real risk culture throughout a company will create organizational resilience. Risk management and

organizational culture should not be understood separated either. Risk management, namely, should be merged with daily activities to cultivate the risk management mindset from the top management all the way down to every employee in order to provide with an effective system to prevent risks and give early warnings when things are going the wrong way (Booz Allen Hamilton Inc. and Weil, Gotchal & Manges LLP 2004).

Culture cannot be anything else but the real way the things work. The actual situation and moral of the employees show the real culture of the company regardless of the managerial thoughts and intensions about the optimal culture. The intended culture has to be nourished so that it can be rooted to the everyday work. Otherwise the intended culture will remain maybe as a vision or goal but not the way the work is done.

Many world-class companies such as Toyota, Dell, and Wal-Mart are very open with their operations because the competitors cannot copy the culture behind the success (Sheffi 2005, p. 264). Everyone can find out how those companies do their business and what the secret recipe is, but what is different is the attitude of the employees, the loyalty and devotion towards the employer. The focus is again in people and the way of doing things. Culture is rarely implemented by written guidelines but the way people see others work.

## 5.6. Complexity

Complexity affects the resilience of a company, because easier processes and better controllability provides with better understanding of the interconnectivities and thus, enables faster changes to the operations and ability to bounce back when the company has faced adverse events that affect partly or totally to the operations. Complexity as a concept can refer to at least process complexity, supply network complexity and product complexity. Each of these can make the conduct of the business more difficult, and the different forms of complexity are discussed in this part in more detail.

*Product* complexity and *supply network* complexity are interconnected because the more the products need different parts, components and raw materials the more they need sources for their supplies (unless the suppliers are very versatile), which exposes the supply chain to more disruptions and makes the forecasting more difficult (Silva and Reddy 2011). They say also that a higher number of product versions can occupy the

market shares better because customer preferences can be more diversely satisfied, but on the other hand, it complicates the operations. Product complexity consists of three factors: number of components, component interactions and product novelty (Novak and Eppinger 2001). Companies without longer experience from production that require lots of interconnected parts are vulnerable to more frequent and longer disruptions and subsequent interruptions because the complexity adds both probability and severity of the event. Interactivity of parts is a challenging property of the product because if the product is changing over time, even smaller changes in the process can induce changes in the process overall (Khurana 1999).

Supply chain complexity includes numerousness, interconnectivity and systems unpredictability according to Vachon and Klassen (2002). Manuj and Mentzer (2008) define supply chain complexity as follows: "when the level of complexity is uncontrolled, the system is less predictable."

**Table 5.3 Factors of supply chain complexity. Modified from Vachon and Klassen (2002, p. 220)**

| | | |
|---|---|---|
| ❋ Number of processes and sub-processes | ❋ Required worker skills | ❋ Geographical dispersion of suppliers and customers |
| ❋ Number of parts or components | ❋ Product variety | ❋ Number of tiers in supply chain |
| ❋ Interactivity between parts | ❋ Breadth of supply network | ❋ Production scheduling and setup changes |
| ❋ Decomposability* of processes | ❋ Breadth of customers | ❋ Demand volatility |

* Decomposability means that interconnected parts cannot be separated without affecting the entity.

Each factor in the Table 5.3 has a role of making the process, product or the management of those more complicated or uncertain. This table and observations by Craighead *et al.* (2007) approve that product complexity and supply chain complexity are tightly related to each other, because bigger complexities in products and parts drive companies to source from more suppliers making the supply network also more complicated.

As for *process* complexity, Wilding (1998) and Vachon and Klassen (2002) prove that the performance would increase by reducing complexity. Complex operations may require at least small buffers to protect from the risks of disruptions from multiple sources, but as mentioned earlier, flexibility and redundancies have their costs. Product simplification, instead, would make the process easier to manage affecting that the forecasting could be more accurate and simplicity would require less parts and components to store. When there are similar varieties from a component, creating one or few standardized components would very probably have positive impacts on costs and production, because it increases flexibility. Lucent, for example, in early 2000s reduced their number of different platforms from 92 to four, and some filters from 466 to 15, to mention a couple examples, to see that their finance became restored and healthier (Sheffi 2005, p. 187).

Research material proposes postponement as a solution for complexity. By risk pooling companies can rely on aggregate demand of components instead of the demands of all different product variations (Yang and Yang 2010). When they receive more market information they can estimate better the volumes for each product and thus reduce stock outs and selling on a discount. Sheffi (2005, pp. 195-196; 200-201) says that multiplicity of product varieties means lower quantities for each version, and, thus, higher volatility in demand, but postponement has two major benefits: (1) having aggregate demand instead of demand for each product variety; and (2) receiving demand data or having shorter time to market as a basis for forecasting.

Chopra and Sodhi (2004) see that postponement can also mitigate inventory risk. Paint retailing is a very good example of postponing the dyeing of the paint until the purchasing which reduces the need for storing all the different can sizes and colours of the paint and keeping only an inventory of base paint in different sizes of cans. However, postponement is not a general solution to problems because it is most applicable only in certain conditions. They include (1) having uncertainty in demand, (2) customer lead times being short, (3) inventory costs being high, and (4) having modular product design (Sheffi 2005, pp. 201-202). Otherwise postponement may be more difficult to implement because other strategies may be more cost efficient or support the processes better. Postponement requires tight coupling which, in turn, makes the supply chain more vulnerable (Yang and

Yang 2010). Another condition for the successful implementation calls for good supplier delivery performance so that the deliveries are timely and with right amounts (ibid.).

## 5.7. Significance of resilience in incidents

Tough competition drives companies to manage disruptions faster and better than their competitors so that the effects of the disruptions to their customers would be minimal. The cost minimization, however, makes it a challenging task to find the optimal balance between profitability and resilience. (Sheffi 2005, p. 12)

Resilience prepares companies to face unexpected events. As listed in this chapter, there are several ways to adopt resilience of different sorts. Here are some examples that show how resilience and preparedness towards different risks and hazards have helped companies to survive and even flourish during and after the events.

When hurricane Mitch hit Honduras and Guatemala in 1998 Chiquita was prepared while Dole was not. Chiquita had alternative sources of bananas and could deliver even though the hurricane had affected seriously the whole banana industry (Silva and Reddy 2011). Latter could not find suppliers that could have supplied them, so Chiquita took advantage and succeeded to increase their revenues by four percent – as much as Dole lost that year (Sheffi 2005, p. 217).

Dell and Apple were affected by the same earthquake in Taiwan in 1999. The catastrophe stopped the deliveries of components for these companies and they had to cope without additional parts (Silva and Reddy 2011). Apple had a backlog of months to be fulfilled with specific configurations, but Dell utilized a few days' note build-to-order strategy, which gave Dell the luxury of flexibility to assemble such computers that they could assemble with the parts at hand (Sheffi 2005, p. 228). It turned out that Dell increased both their market share and turnover, whereas Apple lost them (ibid. p. 229).

In 2002 29 U.S. West Coast ports made a 10-day lockout which jammed logistics of dozens of thousands of containers, and incurred $1-2 billion negative total impacts per day (Sheffi 2005, p. 64). Resilient companies had alternative transportation routes prepared so that they could continue shipping via other ways.

Backup systems are important for every kind of companies. Cantor Fitzgerald is a financial service company, which was located in the New York World Trade Center until the towers collapsed. Two thirds of the company's employees lost their lives and the company lost also the physical equipment such as computers, phones etc. in the catastrophe as well. Despite the huge losses the company suffered, they were back in business less than 48 hours after the event, thanks to their backup systems. In two months, they traded 80 percent of their pre-crisis volumes and recovered rather fast from loss of that scale. (Sheffi 2005, pp. 236-237)

These examples confirm that resilience enables faster recovery from losses. It can be so diverse that listing all different methods is challenging. In the end, resilience can save a company from bankrupts, bad losses and even prevent companies from facing incidents.

# 6. FRAMEWORK

The framework of this study is based on the findings and materials from the theoretical literature. Figure 6.1 shows the general outline of the framework. Foreseen risks are shown on the top left corner of the framework with touch points to specified risks, risk categories, sources, and managing these risks. The top right corner of the figure concerns those risks that companies do not see and the two lists present common factors that make the company vulnerable and resilient. The combination of the factors very much determines the level of resilience and readiness to face risks. These two main categories build up the readiness and ability to face risks and recover from losses. When they are low, companies are vulnerable being under serious threats to business continuity, while resilient companies very probably can maintain their business continuity and recover from incidents when they occur. After all, the preparedness is a critical factor determining whether the company is going to pay a high price for the incidents or enjoying the continuity of their business.

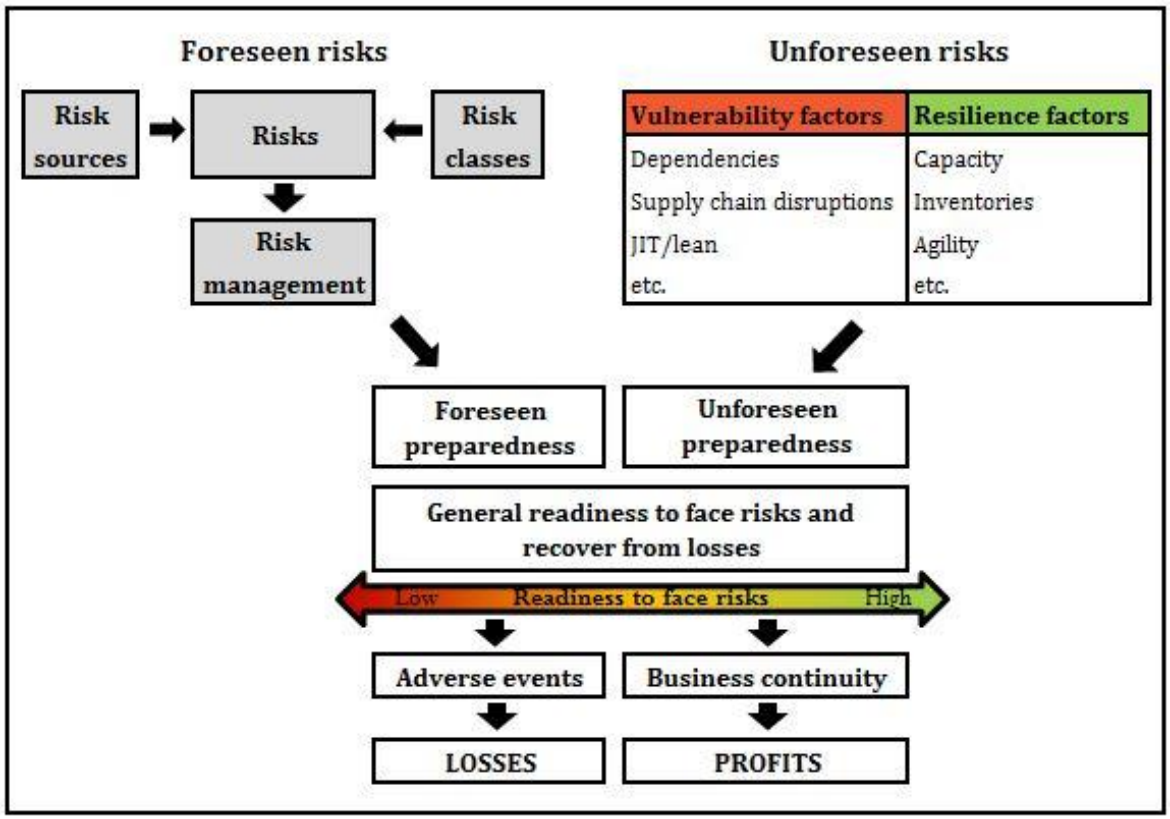


**Figure 6.1 Simplified framework**

The framework is elaborated in the following paragraphs, and the parts of the framework are shown in more detail.

**Foreseen risks**

Risks surround companies regardless of the location and the industry they are operating in. The structured risk identification model is based on the classification by Casualty Actuarial Society (2003) as for risk classes, and Christopher and Peck (2004) what comes to risk sources. It forms a table where the risks are identified by these two dimensions. Therefore, each risk and cell in the table can be associated to two different risk management subcategories. These subcategories form the enterprise risk management, ERM, which is a common practice particularly in large companies.

The identification of risks is important for companies to be able to prepare for their realization. Not all possible risks ever realize, but if they did, they could ruin the business totally or at least partially. In addition, categorizing risks under different risk management practices can make the risk prevention processes easier, because after having sorted all or some of the risks under relevant classes and sources, the approach is structured and the solutions for similar risks can be found simultaneously.

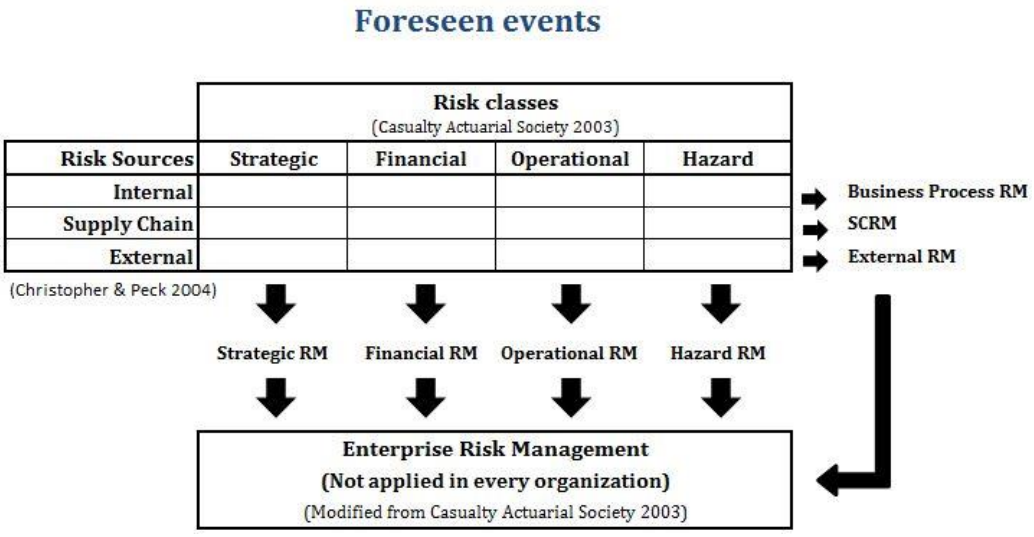


**Figure 6.2 Risks and risk management practices**

**Unforeseen risks**

The second distinct part of the framework consists of the factors that determine the level of resilience in the company. The quality of the ERM is a good proxy of the resilience, because a narrow and limited ERM will most probably lead to lower resilience since resilience, as a wide concept, requires also a wide perspective of the enterprise risks. It is probable that companies are often seeing them somewhere in the middle of the resilience scale. Few companies, assumingly, possess only factors related to vulnerability or resilience, but they may be more vulnerable in some parts while some other parts can be their strengths. Therefore, this is not only black and white categorization, but instead more like a combination of vulnerability and resilience.


| Vulnerability factors | Resilience factors |
|---|---|
| Connectivity and dependencies [1, 2] | Capacity [1, 11, 13, 21, 23] |
| Supply chain disruptions [3, 4, 5, 6, 7, 8, 9, 10, 11] | Agility, adaptability [1, 13, 24, 25] |
| JIT/lean practices [5, 6, 10, 12] | Collaboration and supply chain visibility [1, 2, 26] |
| Reduction of suppliers [5, 6, 10, 19] | Production flexibility [10, 11, 13, 21, 23] |
| Global supply chains [5, 6, 8, 10, 11, 14, 21] | BCP or other plan [11, 13, 21, 27, 28] |
| Outsourcing [6, 8, 12, 20] | Inventories [1, 13, 21, 23] |
| Process complexity [6, 13, 16, 17, 18] | Spare systems [13, 30] |
| Product complexity [8, 13, 15, 16] | Sourcing flexibility [1, 7, 13, 20, 31] |
| Product sensitivity for conditions [1] | Asset dispersion [1, 30] |
| Process sensitivity for conditions [1] | Financial strength [1, 29] |
| External uncontrollable changes [1] | Critical spare parts [29, 30] |
| Deliberate threats [1, 13] | Preventive maintenance [29, 30] |
| Negligence of employees [29] | Culture [13, 21, 22] |

[1] Pettit et al. 2010
[2] Hallikas et al. 2004
[3] Tomlin 2006
[4] Craighead et al. 2007
[5] Wildgoose et al. 2012
[6] Norrman and Jansson 2004
[7] Yang and Yang 2010
[8] Silva and Reddy 2011
[9] Asbjørnslett 2009
[10] Tang 2006
[11] Blackhurst et al 2005
[12] CFO Research Services 2009
[13] Sheffi 2005
[14] Manuj and Mentzer 2008
[15] Novak and Eppinger 2001
[16] Khurana 1999
[17] Wilding 1998
[18] Vachon and Klassen 2002
[19] Hofmann and Greenwald 2005
[20] Berger and Zeng 2006
[21] Christopher and Peck 2004
[22] Booz Allen Hamilton and Weil, Gotchal & Manges LLP 2004
[23] Chopra and Sodhi 2004
[24] Lee 2004
[25] Wright 2013
[26] Bello and Bovell 2012
[27] Cerullo and Cerullo 2004
[28] Castillo 2004
[29] Theme interviews
[30] Risk management professionals
[31] Blome and Henke 2009
[32] Hendricks and Singhal 2005b
[33] Rice and Caniato 2003

**Figure 6.3 Vulnerability and resilience factors**

Vulnerabilities include, for example, supply chain disruptions noted by a number of researchers, JIT and lean manufacturing strategies and outsourcing (CFO Research Services 2009). Global supply chains is also noted by several studies, and Pettit *et al.* (2010) list many other vulnerabilities, for example, limited resources, unbalanced environment, and sensitivities in product properties or processes. Resilience can be attained by redundancies, flexibility and risk pooling (Sheffi 2005), by having an established business continuity plan (e.g. Castillo 2004, and Cerullo and Cerullo 2004), capacity and dispersion in assets, collaboration with business partners, and adaptability in operations (Pettit *et al.* 2010). These factors are numerous, and aforementioned are the most central ones found from the material. Figure 6.3 provides with more complete list of the factors, but even that is not fully comprehensive. There could have been also resource availability, market position, product quality, and production resource efficiency, for instance, included in the resilience list, but too heavy table would not serve the practitioner either.

**Consequences**

The company's readiness to face risks derives from these two entities. The better the risk management and resilience, the higher readiness to face both foreseen and unforeseen events the company has. With narrow risk management practices and more vulnerabilities than strengths, the company is more prone to end up in financial and operational difficulties because prevention systems have not been adequate. On the other hand, when risks have been managed properly and strengths exceed the vulnerabilities it is much more likely that the company can endure the events, and if not, they can be still faster up and running because resilience, in particular, helps *after* the event than before it.

The last distinctive part of the framework concerns the outcomes of the two ends of the scales. It should be reminded that the real companies lie between these two ends, and hence, the extreme consequences represent the extreme ends of the scales. Companies shifted towards vulnerability will probably face more in number and more severe losses than resilient companies. However, all risks do not realize and therefore even vulnerable companies may remain in business without resilience. On the other hand, even the most resilient companies can suffer from incidents. This framework is intended to show the

general differences between vulnerability and resilience and leave the exceptions to sidenotes.

The companies facing adverse events encounter extra expenses from a few different sources. The event itself may be costly for some companies if they are, for example, responsible for compensating the consequences for outsiders. In addition, if the event induces a business interruption for the company, it loses production and sales unless they have adopted resilience in form of inventories or other redundancies that enable them to continue operations on other sites. Costs can be incurred also from the response and recovery phase when the company takes actions and reconstructs if necessary. There are usually many sorts of indirect financial losses related to business interruptions that prevail during the recovery phase. Overall, the possible losses stemming from incidents are quite diverse, and therefore considering additional resilience could be relevant.

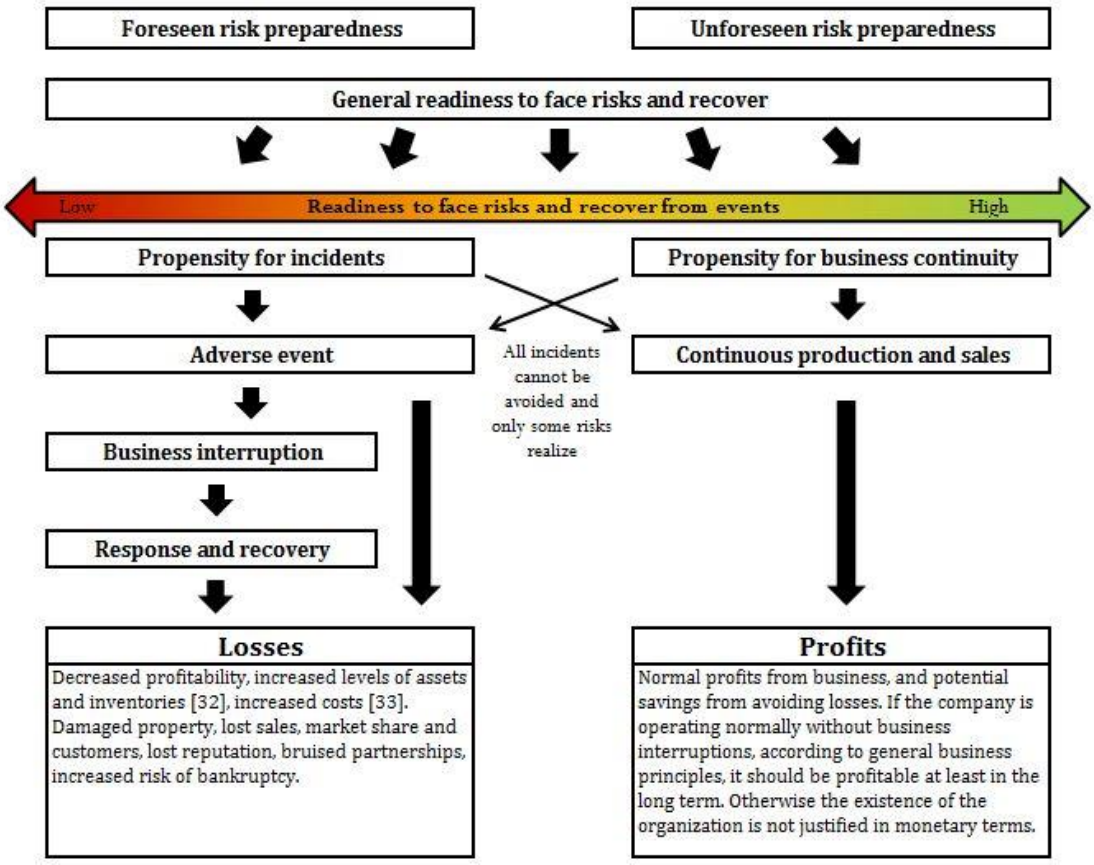


**Figure 6.4 Consequences of different risk readiness levels**

As enterprises exist for different purposes, the general principle is that they generate profits to be capable to exist also in the future. If the business is generally profitable in the long run, resilience tends to increase the business continuity and the existence of the company also in the long term.

**Framework in practice**

As an example, I show how an arbitrary company could use the Risk Readiness Evaluation Tool. Although it would be interesting to see how the case companies would manage with the framework, it would require specific information from the company to do it properly, so in order to avoid giving false information on the case companies, a random example will suffice.

In the first part, the company should place their relevant risks, which are intended to take under consideration, to the table.

**Table 6.1 Examples of risks**

| | Risk categories | | | |
|---|---|---|---|---|
| **Risk sources** | **Strategic** | **Financial** | **Operational** | **Hazard** |
| **Internal** | New production line | Investment financing | Product quality | Plant fire, machinery breakdown |
| **Supply Chain** | | | Lack of visibility, supplier and customer disruptions | |
| **External** | Labor union disputes | Exchange rates | | Inventory obsolescence due to natural hazards |

Then, each risk should be evaluated numerically by their impact (risk level). The method is up to the user because this part is proportional measurement of risks in control. It could be a scale 1-5 where lower numbers correspond to the smaller risks, and higher similarly to bigger risks. Nevertheless, if there is already a numerical method in use in the company, why to change that? When each risk is evaluated, the next step is to evaluate whether the concrete actions made by the company (efforts) are on par, less than adequate, or in some cases more than necessary. This scale should be the same as in risk evaluation so that the percentage would give reasonable results. The percentage shows how much the risks are in control. It is calculated by dividing the efforts by the risk level. Typically, the risks could

always be managed better and therefore, it is expected that the percentage stay somewhat less than 100%. The percentage can be calculated separately for each risk management category as well as for the total percentage. Thus, the company can evaluate their risk management parts in this way. In order to make this tool valuable and practical for managers, there are monetary estimates of the maximum losses for each risk included in the table. NLE, meaning normal loss expectancy of each risk, can help in seeing the financial aspects of the risks and making priorities for improvement decisions. The uncovered NLE is assumed to correspond to the deficit of the efforts with respect to the risk level.

**Table 6.2 Risk evaluation and risk management subcategory percentages**

| Risk | Risk level | Efforts | Pct. | NLE | Uncovered NLE |
|---|---|---|---|---|---|
| Plant fire | 5 | 3 | 60,0 % | 30 M | 12 M |
| Product quality risk | 5 | 4 | 80,0 % | 15 M | 3 M |
| New product line | 4 | 3 | 75,0 % | 12 M | 3 M |
| Machine A breakdown | 4 | 3 | 75,0 % | 6 M | 1.5 M |
| Financing new investments | 3 | 2 | 66,7 % | 3 M | 1 M |
| Customer A disruption | 3 | 2 | 66,7 % | 2.6 M | 0.9 M |
| Supplier A disruption | 3 | 2 | 66,7 % | 2.5 M | 0.8 M |
| Exchange rate risks | 3 | 3 | 100,0 % | 1.8 M | 0 M |
| Lack of visibility to supplier B | 3 | 2 | 66,7 % | 1.7 M | 0.6 M |
| Inventory obsolescence | 2 | 1 | 50,0 % | 1.3 M | 0.7 M |
| Labour union disputes | 1 | 1 | 100,0 % | 0.1 M | 0 M |
| **TOTAL** | **36** | **26** | **72.2 %** | **76 M** | **23.5 M** |
| | | | | | **30.9 %** |

| Risk management part | Risk level | Efforts | Pct. | NLE | Uncovered NLE |
|---|---|---|---|---|---|
| Business Process RM | 21 | 15 | 71,4 % | 66 M | 20.5 M |
| SCRM | 9 | 6 | 66,7 % | 6.8 M | 2.3 M |
| External RM | 6 | 5 | 83,3 % | 3.2 M | 0.7 M |
| Strategic RM | 5 | 4 | 80,0 % | 12.1 M | 3 M |
| Financial RM | 6 | 5 | 83,3 % | 4.8 M | 1 M |
| Operational RM | 14 | 10 | 71,4 % | 21.8 M | 5.3 M |
| Hazard RM | 11 | 7 | 63,6 % | 37.3 M | 14.2 M |

Practical concerns may arise from the use of this tool when the risks of groups and subsidiaries are mixed, because some huge group level risks may be smaller risks for some subsidiaries and larger for some other units. Similarly, risks that seem small at the group level may be high risks for certain subsidiaries (see Table 6.3). Therefore, the scope of the inspection should be decided properly in advance so that the different figures will not be mixed. Future studies could refine this tool to create a scaling function so that the risks of group and subsidiary level become comparable.

**Table 6.3 Comparison of risk levels at group and subsidiary level**

| | **Group level** | | **Subsidiary level** | |
|---|---|---|---|---|
| **Risk** | **Risk level** | **NLE** | **Risk level** | **NLE** |
| Loss of key supplier | 5 | 10 M | 2 | 0.5 M |
| Technological change | 3 | 7 M | 1 | 0.2 M |
| Plant fire, machinery breakdown | 2 | 2 M | 5 | 15 M |
| Flood risk | 1 | 1.5 M | 4 | 4 M |
| **TOTAL** | **11** | **20.5 M** | **12** | **19.7 M** |

Now that foreseen risks part has been done, we can move on to unforeseen risks. This part has been changed a bit from the framework so that the evaluation would be less complex. There are no vulnerability and resilience factors separately, but those have been combined into factors that have both negative and positive aspects. Each factor has a scale from -3 to 3. Zero has been omitted because of the design of the table, but factors that would be marked as zero can be left empty, because zeros do not affect the score.

**Table 6.4 Resilience evaluation tool**


| | -3 | -2 | -1 | Factor | 1 | 2 | 3 | |
|---|---|---|---|---|---|---|---|---|
| Many strong dependencies | | X | | **Dependencies** | | | | Only weak dependencies |
| Frequent disruptions | | | | **Supply chain reliability** | X | | | Disruptions happen rarely |
| No buffers at all | | X | | **Buffers in operations** | | | | Buffers enough to secure more than normal fluctuation |
| Stages are interconnected and require numerous parts | | | X | **Process and product complexity** | | | | Stages are streamlined and use few components |
| Employees are severely reckless | | | | **Employee morale and culture** | | X | | Employees are concerned of safety and regulations |
| No excess capacity | | | | **Capacity utilization** | X | | | Considerably free capacity |
| Poor ability to make changes rapidly | X | | | **Agility and adaptability** | | | | Excellent ability to make changes rapidly |
| Neither collaboration nor visibility in supply chains | | | | **Collaboration and visibility** | X | | | Extensive collaboration and visibility in supply chains |
| Products can be produced only in one line | | | X | **Production flexibility** | | | | Products can be produced in several lines and locations |
| No prepared plans at all | | | X | **Preparedness and continuity plans** | | | | An up-to-date BCP |
| No backup systems whatsoever | | | | **Backup systems** | | X | | Spare systems available |
| Impossible to switch suppliers | | X | | **Sourcing flexibility** | | | | Many alternative suppliers available |
| All assets located in the same location | | | | **Asset dispersion** | | | X | Many locations in different parts of the world |
| Getting loan is difficult and costly | | | | **Financial strength** | | X | | Finance is healthy, additional investments easy to arrange |
| No at hand at all | | | | **Critical spare parts** | | X | | Widely available |

**Absolute score:** **2**
**Average score:** **0.13** (= 2/15 = 0.133…)
**Coefficient:** **1.044** (= 1 + 0.13/3 = 1.044…)

There are 15 factors and after evaluating each according to the scale, the total score is calculated by summing up the values from each factor. Therefore, the absolute score is always between -45 and 45. The average score is the more important figure, because it determines the overall scale of resilience by scale -3 to 3. This figure becomes a coefficient for the percentage calculated in the previous part. The scale per se would not be optimal to be coefficient because of the negative range in the scale, so by a simple calibration,

coefficient will get values between 0 and 2. It means that at worst, the coefficient drops to zero (which is practically impossible to reach) and similarly, the coefficient doubles the percentage if each factor marks the best score, which is practically impossible to reach, too. The formula to calculate the exact coefficient is thus as simple as $1 + \frac{X}{3}$, where X denotes the average score.

It can be argued whether it is meaningful to combine risk management percentage and resilience coefficient, because the theoretical basis of such formula does not exist. Therefore, the calculations of this tool should be taken directive per se. Moreover, the two figures can be viewed as separate entities as well. However, regardless of the reality of the percentages at the first evaluation, this instrument enables the observation of the risk management and resilience development due course by comparing the results from time to time. Additionally, even though it does not have theoretical background as for calculations, it is not even intended to measure any estimates to loss sizes, but rather the readiness of the companies to withstand shocks and tell whether the readiness is high resulting probably in smaller losses, or lower ending up complicating the recovery process.

The result of this practice is a single percentage, which tells an approximate level of the risk management including both foreseen and unforeseen risks. For this arbitrary company it would be $71.1\% * 1.044 = 74.2\%$. The theoretical range would reach from 0 to 200 percent, but the realistic range is probably from somewhere around 50% to even more than 100%. 100 percent would be a good score, and show that the risks are quite well in control. More than that would be beneficial from risk point of view, and desirable if the costs are within allowable limits. However, the optimal target is subjective and depends on the company's objectives and operating environment. To make the result more reliable, it is recommended that a few different people would participate to give a wider perspective for the analysis. The result would be then getting an average score for each of the 15 factors and summing up the averages instead of one value per factor.

It is crucial to remind that this tool does not guarantee that even the best companies measured by resilience would not face incidents, because some risks are simply out of control. Take for example METAL1, one of the case companies, whose resilience looks pretty solid, but rather frequently face losses owing to incidents at their critical supplier's

site. Hence, resilience or risk management cannot always prevent even familiar risks, but good preparations can speed up the recovery.

The framework enables also observing smaller entities such as single risks, functional areas, regions, products and the list goes on. It is recommended that greater risks would get more efforts, or at least the target would have been set higher than smaller risks, because bigger risks need better control and induce larger losses if they realize.

This approach does not consider the upsides of the risks, because it would complicate the framework. This is primarily a method for observing the downsides so that risk management and resilience would help companies to avoid the negative consequences of the incidents.

# 7. EMPIRICAL ANALYSIS AND RESULTS

This part reveals the most important findings from the theme interviews and questionnaire, which were used for gathering the empirical material for the study. All theme interview questions are presented in appendix 1, and the graphics of each questionnaire question in appendix 2 to get additional data on top of the materials provided in the text. The structure of the chapter follows the structure of the framework starting from risks and risk management, followed by resilience and the consequences of incidents. Firstly, however, the background, introduction of the case companies and some general findings are provided.

## 7.1. Background

The results of the case studies lean mostly on empirical analysis of the data, but it is "the most difficult and the least codified part of the process" (Eisenhardt 1989, p. 539). The sample sizes of interviews and questionnaire are rather small, so utilizing any statistical methodology does not fulfill the qualifications of reliable statistical analysis. However, this study is rather a directive work towards reconciling academic theory and practical concerns of companies related to business continuity and resilience from a risk perspective than a statistical study, which would prove the findings. Therefore, the results of the analyses are included to give some findings from the topic in practice.

There are two stages when analyzing the cases: first, each of the cases should be understood separately in order to find unique observations from the cases; and secondly, comparing the data in many ways to other cases and finding more universal patterns and conclusions from the data (Eisenhardt 1989). In order to create structured findings from the material, similar topics have been filed together. Naturally, the material of each case company is also available separated so that the cases can be seen "stand-alone".

The guidance that Eisenhardt (1989) gives about the amount of cases and analysis is that researchers should stop gathering data and analyzing when the additional effort does not bring enough value to the study, i.e. the process has become saturated. Additional respondents to interviews could have been useful because the answers differed from each

other sometimes so much that it was difficult to draw any conclusions from them. As for many questions, there were adequately responses because the answers were unanimous. Other industries could have given alternative viewpoints and results, but having two companies from two very different industries was also a decent situation because that enabled to see better the industry-related topics. Unfortunately, some companies had to refuse even though they would have been willing to participate.

## 7.2. Description of case companies and incidents

A brief description of the studied case companies can give a better understanding of the cases that work as the basis for the empirical analysis. The four companies operated in metal industry, and food and beverage industry, two companies in both industries.

### 7.2.1. Case company METAL1

METAL1 is a large multinational company operating in a B2B environment. It has locations in different parts of the world and produces many kinds of products from different metals. They have had several contingent business interruption (CBI) incidents due to failures in the supplier's premises. The supplier's incidents have forced METAL1 to interrupt or reduce their operations due to the unavailability of additional raw material from the markets. The latest incident induced an 8-day standstill, and affected about two more weeks before the effects faded. Lead times for the raw material are several months and therefore the glitches in the supply chain induce business interruptions unless inventories are adequate. They have had also incidents in their own facilities over a decade ago, but there were only a few sidenotes about those incidents on the interviews.

### 7.2.2. Case company METAL2

METAL2 operates widely in Europe and somewhat in other continents as well. Its products are sold to a variety of industries and it has several production facilities in many countries. They have had a couple of incidents in recent years, and one of those was under discussion. The incident was a machinery breakdown episode, which occurred in their own premises, and it caused about five weeks' interruption. Market disruption period lasted about four months after the production restart. The damages spread to several spaces. Throughput time of the production line is weeks, which played also a role in the recovery and

communication, because it took some time to finish the products after the machines could be turned on again.

### 7.2.3. Case company FOOD1

FOOD1 is a subsidiary of a large group of companies. It operates mainly in one country but have a facility and sales in one other country as well. Its products are sold to retailers and for industrial purposes. Their incident was a fire stemming from a hot work procedure where carelessness led to an ignition and severe fire damages in the factory. It caused large-scale physical damage, but another problem was the rearrangement of the incoming raw material that was abundant owing to high volumes. Business interruption took about one month, but the level of production remained at 60 percent for half a year. The indemnity period was two years, related mostly to the long market disruption period. The incident affected very long and timing was very bad, because they were launching a new higher-margin product, but they were forced to postpone the implementation of the new strategy some two years.

### 7.2.4. Case company FOOD2

FOOD2 has expanded into many countries, also outside Europe, while the majority of the business stays in one country. They produce a large variety of consumer products. Their incident was a conveyor problem, where pieces of the conveyor got into the product, which is a severe incident in food and beverage industry. The conveyor was replaced and the interruption of the production was roughly six hours. The problem was that nobody knew when the conveyor started losing pieces and how much of the production was contaminated. However, the incident did not affect the market anyhow and the inventories were big enough to replace the affected production. Hence, we discussed also potential factors related to these topics assuming something could have gone worse.

## 7.3. Risks and risk management

The discussions with interviewees had quite much content related to risk management and risks they have faced. The questionnaire complemented the discussions by giving information on the risks that companies have faced and what factors have affected most the size of the loss when recovering, and what actions helped them in limiting the loss.

### 7.3.1. Recognition of the risk

Each company had recognized the risk at *some level* but each of them failed to recognize the risk as it appeared. Usually only very general risks had been recognized, for example, FOOD1 had recognized the risk of fire in general, but the risk of fire during hot work had not been sufficiently recognized. Hazards can occur in so many ways that it seems to be rare that the different scenarios leading to the known risks would be analyzed and known to the company.

### 7.3.2. Preparing for the risk

Since risks that companies face are multiple, the ways to prepare for them are multiple, and even within METAL1 the views between respondents varied. The methods include increasing suppliers, maintaining the production equipment and the working environment in a good condition, expecting support from the group, emphasizing culture of obedience towards guidelines, safety and attitude, and lastly preparing plans for recovery. The answers were very heterogeneous, but they all relate very closely to the incident they have faced. In that sense, companies learn from their losses, and become aware of the specific issues that have been the critical points in their recovery. It would be important to become more proactive in risk recognition and loss prevention, but the willingness to put effort on risk management seems to rise only after they experience the impacts of incidents.

> *We did not have a business continuity plan and we do not have it even now … It is a sort of strategic choice (due to our business structure) … [Consequences of a large incident] can be understood only when it strikes you and you experience it.* (FOOD2, Risk Manager)

Preparedness and lack of it were lifted very high in the survey when considering the factors affecting the size of the loss. 47 percent, which is second most, stated that the loss grew because they were not prepared for that risk. On the other hand, 37% of the respondents thought that their preparedness helped them to limit the losses. This finding makes proactivity look like a strong way to manage risks and secure the finance of the company.

Moreover, in all cases the event was a surprise without any realistic possibility to predict it beforehand. This naturally makes the significance of preparedness even more important

because there are no early warnings that could give reaction time before the real shock occurs. Lastly, when interviewees told their most valuable lessons from the incident(s), almost all stressed the importance of preparedness and proactive risk management.

### 7.3.3. Sources of business interruption

Risk is the factor of size times probability, and this part contributes to the probability factor in the concept of risk. The responses divided very equally between internal processes and supply chain or utility providers. All case companies provided also secondary sources of interruption risks that distributed evenly between internal processes and supply chain or utility provides, too.

The questionnaire revealed that the worst financial impacts come from logistics and supply chain disruptions. 21% had faced remarkable financial impacts deriving from that risk category within three years. Machinery breakdowns and fires both had 11 percent of responses. Regarding all eight categories, 26% had had at least decent negative financial impacts during the last three years.

### 7.3.4. Risk quantification and prioritization

The case companies had slightly different approaches for risk quantification, but practically they had aligned it with definition of risk as a factor of size and probability. It was widely noticed that the actual quantification of the risks was really difficult, and particularly the estimation of the probabilities were left to smaller attention.

Food companies had more sophisticated tools for quantifying the risks. FOOD1 applies an ERM process, which locates the risks into a 2-dimensional map. Their probability estimates have been founded on historical data and experience using statistical methods. FOOD2 has a form with which they analyze several areas of risks so that they can evaluate the risks financially. Exceptionally, they include detectability of the risk in addition to size and probability. However, they and METAL1 both commented that they do not pay attention to probability that much because it would be so arbitrary. Despite that, probability was seen at least in METAL1 as the decisive factor when the size of the risk was equal, but with different probability and impact. In those situations, METAL1 would prioritize risks, whose probability is higher and the impact smaller.

Overall, each company admits that the methods are not so qualified that they could leave their case-by-case considerations out of question.

### 7.3.5. Supplier evaluation

All case companies understand the significance of their suppliers for their business. As Wildgoose *et al.* (2012) recommend, suppliers should be known well in order to avoid and recover from accidents faster. The most comprehensive approach was given by METAL1 saying that they evaluate their suppliers with respect to many variables, and the variables depend on the situation. The 'basic' variables are ability to produce, price, adequate size, and production reliability. When the suppliers are particularly far away, METAL1 considers also safety, financial stability, and the amount of competitors on the market. Furthermore, suppliers at early stage of their business are evaluated by their overall viability, financial prerequisites to survive, the probability to get the project implemented in time, challenges in business and logistics, price, and delivery terms.

FOOD2 had also developed a supplier survey that mapped the condition of the suppliers. It includes their risks, business continuity plans, production rearrangement possibilities, capacity for this client, and some other factors as well. It has revealed the realistic situation of the suppliers that has helped FOOD2 to evaluate their supply risks.

The other two case companies mentioned quality systems, ongoing cooperation, site visits, and expertise as requirements for their suppliers.

## 7.4. Resilience and vulnerability

The contents presented in the unforeseen risk part of the framework are considered and analyzed here in more detail. The major focus is on business continuity plans, dependencies, cooperation and supply chain risk management.

The figure below presents the results of the questionnaire regarding the use of different methods with which companies can achieve resilience. Even though the figures may be rather directive than exact, the chart shows that extra IT systems, insurance and preventive maintenance are the most prominent methods to make the company more resilient. Critical spare parts were also a very common method, which was also used in metal industry case

companies. Collaboration, group level flexibility and adequate amount of suppliers exceeded 50% of the respondents. BCP, however, seems to be partly understood as *any* continuity plan and partly as 'official' BCP, because 32% had a real BCP, and 84% some sort of plan. Inventories, capacity and flexibility, which got decent attention in the theory are applied in one third to a half of the companies responding to this survey. They all belong only to the second quartile of the most popular methods.

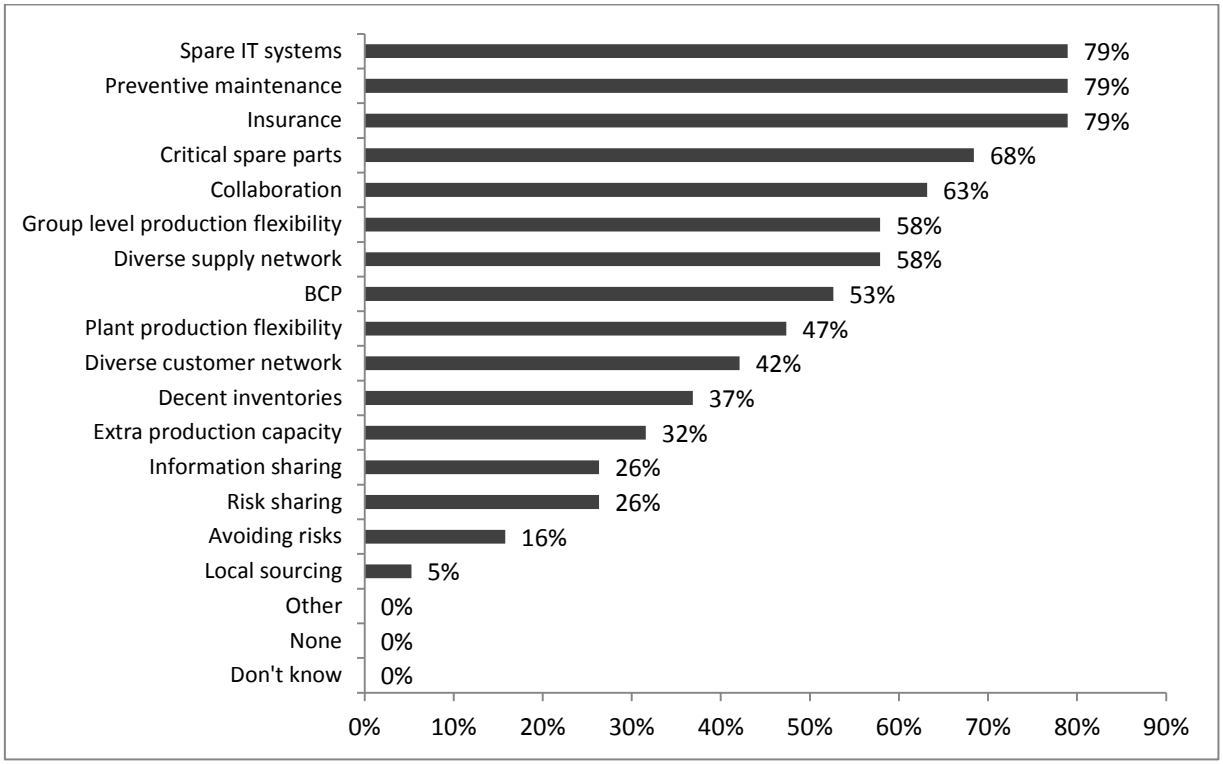


**Figure 7.1 Methods for acquiring resilience.**

### 7.4.1. Business continuity plan

Only one case company out of four had a BCP when they faced incidents and that was not in active use. Fortunately, each company had at least some kind of plan, which has made them prepared for crises. They were called 'recovery plans' and 'key machine analyses' but the contents and purposes of those documents are different than BCP's. The benefits of having a structured approach for business interruptions to quicken the recovery, and reducing panic when crises and incidents are striking are stressed in the theory (see e.g. Cerullo and Cerullo 2004). This study reveals that companies know that such plans are necessary, but there would be room for improvement.

The biggest benefits or potential benefits of BCP according to the respondents were the following five things. First, prepared plan helps in recognition and controlling of the risks. A plan that considers different scenarios, and categorizes and analyzes risks gives them means to prepare also the actions when those risks realize. Another benefit is that alternative suppliers can be thought to replace suffered suppliers in order to enable continuity also in case suppliers cannot deliver as planned. Thirdly, as FOOD1 and METAL2 emphasized, the material streams are very heavy, so a developed plan can make the rearrangements faster. A BCP can dampen the effects of business interruptions by planning the material flows during the downtime if those cannot be stopped. Fourth benefit is that such plans tend to reduce the extra work because the existing plans make the to-do-list simpler and more streamlined. The fifth benefit regards mostly the companies that belong to larger group. METAL2 did not have made precise plans how to utilize the capacity of and help from other plants of the group during the recovery, which could have been beneficial and led to faster recovery. They, however, realized that in the future, as they were planning to create a BCP, they could map the internal suppliers for different scenarios and hence, reduce the time out of operation and be able to minimize the direct and indirect losses.

The small number of business continuity plans used in the case companies might be explained by the fact that they have experience from losses where they have learned the lessons the hard way. The companies already know how to redirect material flows, or who could be the alternative suppliers and so on, but still, it would be strongly recommended to design a thorough plan for also many other kinds of accidents. It can be a costly way to learn the lessons afterwards than study the risks beforehand.

As Castillo (2004) mentions, it is essential to update the plans regularly and after major changes in environment or operations. Most case companies update their plans, but one case company has not updated it since it was created quite long time ago.

According to the questionnaire, BCP was used in 32 percent of the companies, and when other kinds of plans are taken into account, some kinds of plans are found in 84 percent. BCP was fourth most useful method to limit the loss size in general. 42% of the companies with continuity plans were on monitoring phase on a scale planning-implementing-

monitoring-developing. 21% were developing their plans, and the rest were planning and implementing or did not know. Over half of the plans had considered internal dependencies (61%), alternative suppliers (61%), external dependencies (56%), and several different loss scenarios (56%). 28 percent had created their continuity plans based on business impact analysis (BIA) and updated their plans regularly. 22 percent of the plans were tested or simulated. The figures are rather modest, and the plans would be more effective if they included more comprehensive analyses on the business environment, the structure of the business, revenue generation, and the links that connect the functions.

Suppliers and customers' business continuity plans would be useful for companies because minimizing their problems minimizes also other partners' problems. However, these case companies very rarely could say anything about the suppliers BCPs. Only METAL1 knew the closest suppliers' situation with respect to BCP, and the rest could not say. The study by Glendon and Bird (2013) shows much better figures saying that only 20 percent of companies do not even ask whether their key suppliers have continuity plans, and almost 50 percent of key suppliers could provide with continuity plans for the focal client company. The differences are significant with the results of my study, and it would be interesting to know what the reasons behind the differences are.

### 7.4.2. Potential improvements to business continuity

Since the incident of FOOD1 was huge and the consequences were severe, all improvement suggestions related to the prevention of such accidents in the future. They included developing of safety, maintenance and workers' training. Reckless hot work could have been prevented by better emphasis on stronger culture on safety and with better instructions. Therefore, nourishing the right culture and doing small but important actions could avoid seeing such events.

METAL1 also had suggestions for contingent business interruption risks because they have had many of them recently. Their improvements would be having more suppliers and diversifying the raw material base so that they would not be too dependent on only certain type(s) of raw material but could also purchase the materials in different forms. Moreover, they suggest that loss prevention and training of the personnel could be improved. They also mentioned an idea about process change analysis, which would analyze the changes in

the processes, and any changes would not be done before they would know how the changes would affect the operations.

FOOD2 invested in magnets in order to better recognize foreign objects in the products, but as for further improvements, they mentioned only a "real" BCP as a means to improve business continuity. METAL2 had suggestions that did not relate directly to their incidents unlike the other case companies. They thought about a systematic procedure to analyze and map risks as well as update it regularly. They started to analyze the capacity utilization within the group because it could have mitigated the effects of the incident notably. In other words, it sounds like a BCP, as they were planning to create one. Inventories and alliances with large global suppliers were analyzed but they were not realistic in their opinion. They did not even find any other realistic ways to improve their continuity.

### 7.4.3. Dependencies

Two factors came up in the dependency discussions that act strongly behind dependencies. They are (1) the parties whom the company is dependent on, and (2) how the dependency relates to the processes. The first one requires the recognition of the parties that are involved in the business. Raw material and component suppliers and customers are evident facets in the network, but utility providers, logistics operators, regulators, competitors, and many other parties may induce devastating impacts if they fail or change the operating environment radically. It is crucial to understand the host of parties that affect the company in order to become resilient and aware of the risks stemming from internal and external dependencies. The second point is critical to think through, because the dependencies may have several effects on operations. Knowing only the parties that affect the business is not satisfactory without knowing also their impacts, and thus, the analyses on the failures' severity for each party are important as well.

METAL1 has studied both factors, and understands the second point particularly well:

> *[The impact] depends on the dependency. They can be really remarkable factors. In our own process, the duration of the interruption depends on where the incident occurs. We have critical points that interrupts all [our plants] if the incident*

*happens there, or if it happens in [less critical] part, only one plant or even one part of a plant goes down.* (METAL1 Safety Manager)

METAL1 converges with the part of the dependency theory by Hallikas *et al.* (2004) whereby the depth of the relationship correlates with the dependency on that party. METAL1 has a supplier with whom they cooperate widely, but that supplier has had several incidents inducing business interruptions for METAL1. The relationship is important for the company and therefore, maintaining the relationship the dependency renders the vulnerabilities of the supplier as well.

Both metal industry companies emphasized the importance of the utilities in their production continuity. Even though water and electricity among other utilities are important in any production, metal production applies them particularly much, and therefore they are an inseparable part of the production. In fact, they are probably even more important than raw materials and parts used in the production, because inventories can mitigate the interruptions, but due to safety regulations and the properties of the machines and production, power outage, or lack of cooling water forces them to stop production immediately. Getting alternative suppliers and infrastructure for utilities is more difficult than for raw materials and therefore a lack of utilities is affecting the operations differently than materials. Emergency generators and alternative sources of utilities cannot usually help too much to avoid the interruptions, and METAL1, for example, wraps it up that their emergency generator is basically capable of doing the emergency shutdown, but not running the production, which is the case very often.

While metal companies stressed the importance of utility providers, both respondents of FOOD1 highlighted the criticality of raw material supplier dependencies. Because the production volumes are very high, the flow of incoming raw material must be steady and reliable. FOOD1 receives raw materials from very many suppliers because the capacity of living creatures or organisms that produce the raw material is very limited. FOOD1 needs many suppliers to fulfill the demand for raw material, and hence, it eliminates the massive risks of losing a major share of production materials when a major supplier is unable to deliver. However, as the number of suppliers increase, the probability of facing failures increases as Blome and Henke (2009, p. 132) present. The high number of suppliers, on the

positive side, reduces the size of the failure's impact remarkably (ibid. p. 132). In a situation like this, an internal incident, such as the severe fire that FOOD1 faced, may be even more the worst-case scenario, because the external risks have been well dispersed as for sourcing risks. In addition, the properties of the raw material require it being quickly in the process, which creates problems with logistics upon any glitches in the production.

Internal dependencies related mostly to machines. METAL2 gave a short description of theirs, which suits quite well for all case companies:

> *We are seriously vulnerable to our own process. The whole production runs through 'narrow pipes', and as we have learned, it is really sensitive [process]. If a machine breaks down, the whole production stops. Machines are rarely duplicated.* (METAL2 VP, Marketing)

They also explained that the internal dependencies within the group level are very small because each plant produces their own products, and furthermore, they are capable of producing many products of other plants as well. Contrariwise, on the unit level the internal dependencies are severe.

Case companies know their dependencies quite well until the tier 1, but further suppliers and customers are generally not identified. As Hallikas *et al.* (2004) suggest, it would be important to recognize the tier 2 dependencies, but the reality is far from that. It simply means that companies cannot neither identify nor manage the risks emanating from the larger supply network. Unfortunately, a survey by Glendon and Bird (2013) shows that 42% of the supply chain incidents occur beyond tier 1. Therefore, better knowlegde of tier 2 and even further would help in the prevention and mitigation of the losses.

Companies seemed to know the critical dependencies very well, and they had recognized dependencies on less critical parties somewhat well, but it should not be exaggeration to say that still, there is room for improvement, especially with parties that do not relate directly to production. What makes it more difficult for companies, even though they have recognized their dependencies, is that they may not be able to do so much for them anyway owing to lack of alternatives or control, which forces them to invest in loss minimization.

### 7.4.4. Cooperation

This part consists of cooperation activities on risk management, information exchange, and the benefits that case companies have experienced through cooperation.

The activities that have been made are risk mappings, case studies, auditing, visits on other sites within the group, process development with headquarters, safety cooperation, exchange of information with colleagues from other companies, and benchmarking, which did not become a continuous activity. These have been made in cooperation with insurance companies, brokers, clients, suppliers and utility providers, government officials, and professional service providers.

To elaborate on the information that flows between the companies and other parties, the primary content is about material or product quality. Another very common topic is information about demand and forecasts. Furthermore, companies share information on products, processes, and incidents. METAL1 is not satisfied with the production information from suppliers. They also think that it is more important to exchange information between suppliers than customers. Literature, however, does not discuss the collaboration only towards suppliers or customers but takes the approach that it should be supply chain-wide.

The case companies claim that risk management cooperation has not been useless, which is also a finding by Bello and Bovell (2012). The case companies have gained improvements for their operations quite widely, depending on the activities applied. Acquiring best practices in safety, environment, and business overall has been the greatest benefits for METAL1. Additionally, risk mappings have given them a better understanding of their risks so that they can concentrate better on the critical risks. FOOD1 has found improvements to their risk management practices, and they can discuss problems more and more openly than before. FOOD2 has gained benefits from quality audits to their raw material providers, and now they can solve the problems more effectively with them. METAL2 shortlist that they have seen the amount of incidents decrease and improved their safety equipment. Potentially they could benefit even more if they exchanged expertise from case studies and seminars.

### 7.4.5. Supply chain risk management

Wildgoose *et al.* (2012) have created a supply chain health check, where the most relevant questions and responses were chosen to this part. According to the responses, each company, fortunately, knows their critical suppliers. The knowledge of their supply chain is not that deep, because most of the respondents know only the first tier.

Supply chain management (SCM) has not been integrated into ERM or other risk management activities, except in FOOD1, which had spent time and efforts on the integration analyses. METAL1 has also partially applied some techniques to connect SCM and risk management.

FOOD1 and METAL1 keep a record of disruptions and near misses in the supply chain, so that they could decide whether to take actions. METAL2 has such a record too, but they admitted that it is so unsystematic that they cannot make any reasonable conclusions on the delivery reliability of their suppliers based on the record.

All case companies discuss risks with their suppliers. FOOD2 stressed the importance of this in their operations and the risk manager said that they do it 'really much' especially related to quality risks.

Lack of resources was rated as the foremost obstacle to improve SCRM with 63% of the questionnaire respondents. Constant changes in the supply chain, its complexity, and lack of control were each chosen by 37% of the respondents as the second largest problems. The vast majority (84%) cooperates little in SCRM, 11% significantly, and 5% do not have SCRM cooperation at all with their partners.

Compared to theory, the responses are in line with the previous findings. It is somewhat visible that supply chain risk management is of great concern in companies, but financial constraints are still strongly limiting the effective use of SCRM practices.

### 7.4.6. Balance between resilience and costs

This topic was very difficult to answer because this aims at the core problems of doing continuous business profitably. No wonder that companies said that they have to consider costs more than risks. Fortunately, the trend seems to be aligning little by little towards risk

management as well, because case companies alleged that they put more and more efforts on safety, loss prevention, and recommendations by insurers so that they could avoid business interruptions.

FOOD2 risk manager shed some light on their view of the topic as follows:

> *Production facilities are extremely interested in the continuity, functionality and faultlessness of their own production. When the matter is provided appropriately…you can be satisfied of how sincerely the issues are received. When it is communicated clearly, it will be generated within the budget by actions or investments.*

METAL2 has been even overly careful, which was financially burdensome. In real life, these decisions may not be always simple and easy because it is about ensuring the workers' safety and business continuity but still minimizing costs as much as possible and reasonable. This is the question at the core of the problem faced by companies, and therefore this topic could provide with lots of further research opportunities.

## 7.5. Consequences of business interruptions

Empirical material revealed plenty of factors that determine the size of the loss in the big picture. Despite the diverse nature of the incidents, it was possible to find some similarities between the cases. Additionally, the survey displayed the distributions of different factors, which would be difficult to estimate based only on interviews of four companies. Following parts contain more specified details of the factors, and Figure 7.2 shortlists the most crucial factors, which increase (bar below zero) and decrease (bar above zero) the size of the loss.

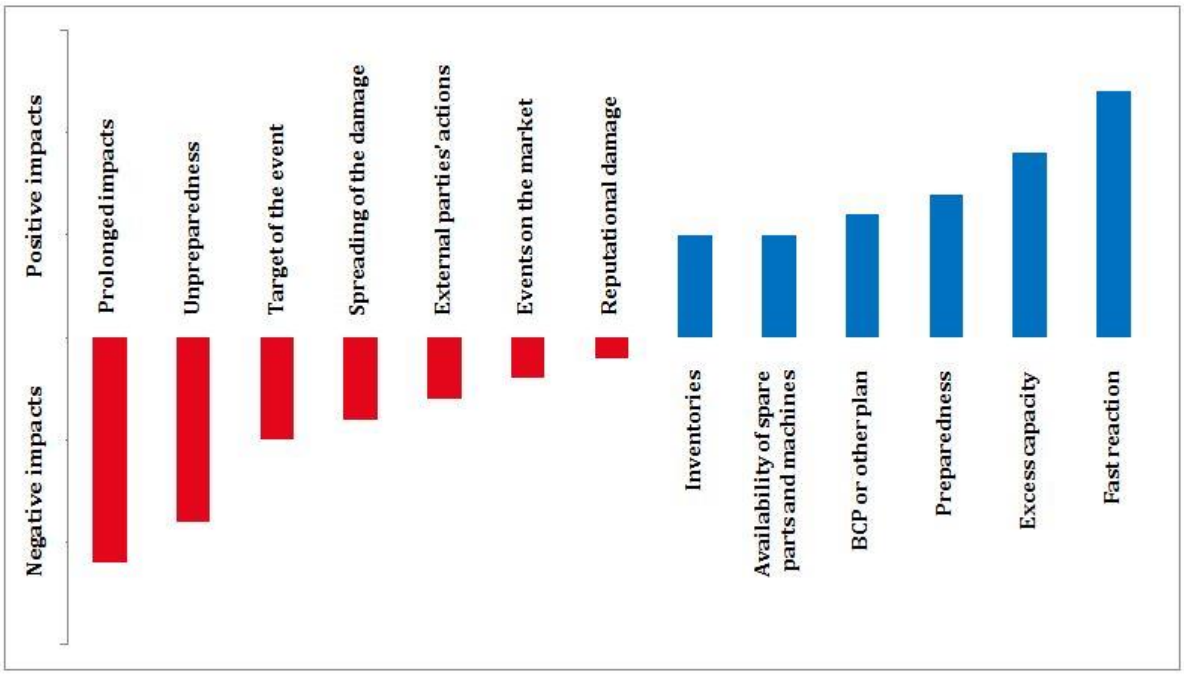


**Figure 7.2 Factors affecting the size of the loss according to the questionnaire**

### 7.5.1. Immediate impact of and actions after the incident

It is evident that the major impact was an interruption of the operations. FOOD2 had only a short stoppage, and the greatest impact was the investigation of the lately produced products whether or not they were contaminated and valid for sales. The consequences to raw material streams were also notable. FOOD1 had to redirect the incoming material while METAL1 needed it more. When the incident occurs in own premises it incurs an excessive inbound raw material stream, while failures in suppliers' sites lead to material shortages. Regardless of the node in the supply network where the incident happens, glitches tend to require exceptional materials and inventory management.

Communication is a key method for solving acute problems, because information from the damaged party about recovery schedules may help in planning the actions with alternative material sources. Contracts with suppliers and customers can make the decision-making more complex; as safety manager of METAL1 explained, the contracts and lead times are typically long, which makes the sourcing outside contracts complicated. Single purchases with spot contracts are an option, but because the raw material is not available on a store shelf but normally requires weeks or months to be ready for delivery, spot contracts have

also the challenge to match the price and exceptionally quick delivery time so that both are willing to enter the spot contract.

FOOD2 and METAL2 put also some effort on the investigation of the incident and invested a lot of money to prevent such incidents from happening again. METAL1 has very little to do about it because it was a contingent business interruption and hence, out of their control. FOOD1 had financial challenges throughout the recovery process, and the cause of the incident was after all quite avoidable. It tells about attitudes towards the recovery and further loss prevention when the incident is investigated thoroughly after the loss and many changes have been done in order to prevent further incidents.

Fast reaction during the incident was the greatest factor that affected the size of the loss according to the questionnaire. 63 percent of the respondents considered rapid actions being the best practices to reduce the loss.

### 7.5.2. Quality problems

Food industry case companies were suffering from the quality issues related to their incidents. Metal companies also emphasized quality issues in our discussions in general, but quality was not an issue in their incidents.

FOOD1 got reputation damages because the product quality, which is greatly sensitive within food industry, was varying after the restart, affecting reduction in the consumers' trust in the brand and the products. Trust can be lost in a flash but earning it back can be time consuming. FOOD1, however, claimed that their reputation problems remained only temporary during the recovery. FOOD2 had to spend resources on the quality checks of the production after they noticed that the conveyor might have contaminated some of the production.

### 7.5.3. Damaged relationships with partners

Business interruptions may have negative impacts on customer and supplier relationships if the interruption causes losses and disadvantages for them. An inability to deliver ordered deliveries to customers can have wide adverse effects on them. On supply side, losing large orders from a big customer can bother the business of the supplier. Frequent events that

induce such feelings for the partners may end up badly. Fortunately, long cooperation has benefits as explained in the theory, and established personal relationships as well as mutual trust can overcome temporary disruptions in the operations.

Interestingly, the safety manager of METAL2 asserted that the interruption affected the customer relationships, or even terminated them, but the marketing manager of the same company alleged that it did not have significant impacts because they have lasted for so long time that they endure such events.

> *We have customers with whom we have cooperated for decades. They are very long-lasting relationships. [In this industry] one does not just jump from supplier to another, but there are long relationships behind.* (METAL2 VP, Marketing)

Marketing manager is more convincing source of that information, but it is interesting to hear how others can see (or expect) consequences that others do not see. This point just validates the other findings that the interruptions have so many different consequences that their complete understanding can be difficult.

### 7.5.4. Reputation damages

Both metal companies raised the concern that repeated interruptions can jeopardize the reliability image of the company as a reliable supplier. Delayed or cancelled deliveries are not beneficial for their customers that can make them change their suppliers. METAL1 says that in B2B markets the reputation is not that important as in consumer markets. When we talk about minerals and raw materials, it does not usually really matter where it comes from and who has delivered it, but quality and price are more important. However, for simplifying the business, it is beneficial to find suppliers that can deliver right amounts at right times with right quality and at a fair price. Now, if one supplier has proven to be unreliable and the competitor not, there is an urge to switch suppliers because the emotional factors are not that deep as in consumer markets. Therefore, the bad reputation incurred by interruptions can have negative effects on business.

The reputation problems of FOOD1 had temporary impacts, as discussed briefly earlier, but it is noteworthy to mention that the situation within that market was beneficial for FOOD1 because it was practically a duopoly of two large companies with some smaller

players. That situation helped them to survive because the retailers wanted to maintain the competition in the supplier markets, and did not pay that much attention to reputation but price. In other competitive environments, the reputation could be the tiebreaker when deciding the suppliers.

### 7.5.5. Worst consequences of the incident

Since business is about creating value and profits it is sure that the interruptions of the value creation processes are evident drawbacks of the incidents. All interviewees agreed that financial losses, whether they were called "margin losses", "production losses", "lost sales", or "increased costs", were the worst impacts of the incidents. The accidents that case companies faced affected only low-margin product categories, but in each case, the volumes are high. Every week, day and hour of stopped production has a negative impact on sales, and eventually on the bottom line.

Other factors than directly related to finance are plentiful. Most common severe consequences were lost market share and shelf space, which both relate tightly to sales performance as well. Markets are, however, so scattered and the market shares so small that the market share changes are minor and difficult to notice exactly. Very specialized products can be more critical, because there are fewer providers, and the customers of them may be more vulnerable when those products are not available. Business interruptions forced case companies to disappoint their customers by being unable to sell the ordered amounts, and they had to receive their material requirements elsewhere, which added to the market share of the competitors, albeit in most cases only temporarily and to small extent. FOOD2 had inventories to cover all the lost production, but their business interruption was only a matter of hours. FOOD1 and METAL2 had about 5 week's interruption and the standstill of METAL1 exceeded one week, so inventories for as long periods as five weeks would be very expensive to maintain. Furthermore, if the stored material is diverse, there should be an inventory of many different goods or whatever is stored, which would increase the costs even more.

A remarkable adverse influence of the event was an extra hassle and very ineffective use of resources. Exceptional processes caused by exceptional events make companies to focus their efforts on recovery and restoration instead of developing from the original level. The

incidents induce not only added costs but also incompetence because other companies can utilize the resources better on growth and development, while hurt companies do loads of work in order to achieve the level they were before the incident. If the effects of the incident prolong, the competitive disadvantage has more impact on the companies also in the future, because the gap between the hurt and unhurt companies becomes wider. FOOD2 highlighted that even though the disruption was short, they had to pay much attention to the investigation of the possibly contaminated products, because they had not noticed the disruption immediately. The extra work affected the normal operation for a couple of weeks. Although the industry is heavily regulated, it is also their own interest to investigate the product saleability to maintain the high brand image.

METAL2 also pointed out that business interruption incidents have impacts on customers, even though the relationships do not terminate typically from smaller reasons. However, subsequent delivery failures and deteriorated reliability can gradually make the customers to switch to other suppliers. They added that internal impacts are diverse as well. The resources must be reorganized and are probably consumed inefficiently during the recovery, and the routines are lost to some extent. Interestingly, there are also 'soft' elements regarding the employees; how will they react and does it affect that they may be concerned of losing their jobs and using the machinery if the equipment is dangerous and the financial state of the plant decreases so that eventually it must be shut down? These remained unanswered but the concerns are surely relevant from the workers' perspective.

### 7.5.6. Other factors affecting the size of the loss

There were also some other factors that were brought up in the discussions and survey, and they are discussed briefly below.

**Redundancies**

As covered in the theory, alternative production locations and excessive capacity can be helpful assets for a company that has part of their capacity down. Even though reorganization of the production would take some time, in larger incidents it can be crucial. Flexibility overall is beneficial upon disruptions because if some parts of the production

are up and running, the most important and highest margin products can be prioritized and produced so that the losses would be as small as possible.

**Duration of the downtime**

Duration is obvious factor related to the costs of the business interruption, because the longer the operations are out of action the more it will influence markets, supplier and customer relationships, company's financial stability, employees, and so on. This is the worst factor affecting negatively to the size of the loss according to the questionnaire. Although this is very evident factor, it is also very important having impacts on several other factors. FOOD1 and METAL2 had longer business interruption, and therefore their losses were more severe than the other case companies' losses.

**Minimizing the damages**

All case companies agreed that the loss limitation (or its failure) affects the total losses, because the sooner the damage is in control the less its consequences affect different parts of the operations and the sooner the companies can restore their damaged property or processes. METAL2 especially benefited from the actions that helped to limit the damage so that the property was damaged only in smaller area. Therefore, their recovery efforts did not need to be larger, and they could shorten the standstill making the market effects minimized.

**Timing of the incident**

In two cases, the timing of the incident affected the loss. METAL2 was fortunate to encounter the accident during a low season, when the market demand was lower, and the customers could get the alternative material from other sources. It was good for the company that their customers did not have to interrupt their operations even though they moved temporarily to customers of their competitors, because in this industry, the relationships between suppliers and customers last long, and the suppliers are not easily changed.

FOOD1, in turn, had the loss in strategically bad timing, because they were moving from lower-margin products to higher, and therefore the strategy implementation had to be

postponed and started over after two years. The financial impact of the delayed launch was estimated high, because of the difference in margins leading to lost profits, let alone the physical destruction. The market itself does not have notable seasonal fluctuation.

It did not surprise that the size of the loss depends on timing, but it seems that at least the phase of the season and changes in operations and strategy are affecting the loss. Losses are always adverse events, but not all case companies had extra effects due to the timing. Researchers could study the effects of timing more deeply in the future to get better results.

## 7.6. Returning to markets

This part regards the factors that hindered and speeded up most the recovery, other noteworthy factors related to return, and effects of the interruption on market share, reputation, and competition.

### 7.6.1. Factors hindering the recovery

Physical damages were naturally very common factors delaying the return to markets. FOOD1 faced most severe damages, METAL2 somewhat as well. METAL1 could not do almost anything for the speeding up because the incident happened at the supplier's facilities. The extent of the damage is obviously one decisive factor that determines quite much the overall scale of the damage, but other factors can make major differences when applied well or poorly. Other mentioned factors related to officials and regulations. Especially in the food industry, they are not allowed to restart before inspections and approvals by officials even though they would be capable of restarting. FOOD1 added that after the physical damages had slowed down the recovery, they faced other obstacles on the markets due to lost shelf space and quality problems. METAL2 confessed that their understanding of the process is imperfect, and hence the recovery was hindered. They faced challenges in estimating the impacts and durations of the restart because of that, but unless they had succeeded with their estimates, it could have made their recovery slower.

*Potential* hindering factors were discussed as well, and the concerns related to customized machines and their slow repairs or replacements, unavailability of rare chemicals that only a few companies produce globally, and maintaining supplier relationships in situations

where the company has to stop the orders for some time, because smaller suppliers may not endure such breaks.

### 7.6.2. Factors speeding up the recovery

The respondents brought up many factors that helped them to get back to business faster. Both metal companies held inventories that mitigated the business interruption impacts so that they could deliver some orders. As discussed in theory, inventories are expensive and when the amount of stock keeping units is large, stock keeping becomes very costly.

All case companies brought out the role of communication in the discussions of returning to market. They saw it important because they wanted to give right information about the situation to customers and other stakeholders. When METAL2 gave a good estimate on their recovery timetable to the customers, they were able to make their contingency plans to match the expected time to continue the cooperation.

One helpful but questionable factor is experience from losses, because those are probably the best teachers while they have also their costs. Case companies, such as METAL1, do not have very strict guidelines on what to do when their supplier's machine gets broken because they already know what should be done in those cases. The other way round, METAL2 expressed their ignorance of the consequences as well as any actions that should be taken because they did not have faced incidents for decades and lacked such experience.

Business continuity plans were mostly left out from these discussions because METAL1 knew already the steps after they heard about the supplier failure. FOOD2, for their part, could keep the damages so small that the plans did not provide that much help. FOOD1 said that their experience from previous fire was valuable, and therefore the BCP would not have helped as much as without experience.

FOOD1 and METAL1 had both five weeks long interruption, but their interviewees mentioned that the rapid reconstruction helped them to recover more quickly. Fast reaction after the outburst of the event is also a key activity to limit the losses.

Good product quality can be valuable asset for companies because as METAL1 expressed, their customers want the good quality of their products and thus, they would be more

reluctant to switch to other suppliers. It can make the restart of the business easier because they have a product that their customers want. Companies with poorer or variable quality may encounter situations where their customers have changed suppliers after bad incidents. When they realize that the quality is better elsewhere and they may want to continue with the new suppliers, the original supplier is in trouble. METAL1, as a subsidiary of a large group, was able to lean on the product variety of the other plants of the group to get orders to the customers even though they were unable to deliver.

### 7.6.3. Impacts on market share

These specific food industry case companies have larger market shares on their markets than metal companies. FOOD1 suffered most among the case companies regarding market shares. Their insurer estimates that the market share dropped lower than usual for one year after the incident, requiring possibly another year to establish the desired product mix with higher margins. The company itself assumes that their market share will never recover to the pre-incident level. Another difficult factor for FOOD1 was that they had to buy their shelf space back selling with lower prices, which diminished even more their low margins. According to the company, the extra shelf space costs have become somewhat permanent.

This company operated on a market where competitors eagerly took the advantage of the worse position of others by buying from the suppliers of FOOD1 in order to complicate the situation for FOOD1. However, they are one of the large players on their markets and that may have helped them to remain on the market better. It is also a benefit for the retailers that the competition remains tougher. This, again, could be studied better in the future.

METAL1 belongs to large group that has a significant market share globally, but a single plant's own market share is marginal and therefore the consequences of short business interruptions, as METAL1 has recently seen, remain modest. METAL2 had only temporary consequences that amended due course.

The biggest threat for market share is the diminished courage to make larger sales contracts stemming from fear of new incidents. Market shares tend to be quite steady but if incidents occur often, it may reduce the courage of salespersons to offer longer and bigger contracts, because they may become difficult to fulfill when the production is abrupt.

### 7.6.4. Impacts on reputation

Reputation is more or less important property for any company, but as for the case companies of this study, food industry is more concerned of their reputation than metal companies are. Each case company operates on B2B environment, but the products of food industry are almost purely consumer products whereas the products of metal companies more rarely end up in consumers' hands. Therefore, the mindset of the two industries differs slightly.

However, product quality was a concern of each company, because regardless of the type of the customer – a company or a consumer – they respect higher and more stable quality. FOOD2 has strong brand, and quality problems among other reputational damages would be severe. They claim that there are so popular products that consumers would look forward to getting them back, but some products could be in worse situation because of other competitive products.

Risk manager of FOOD2 says that product recalls may have ambivalent message: it tells that something bad has happened, but in contrast that the company carries its responsibility. Communication is in critical position so that the message is understood correctly.

### 7.6.5. Other factors to consider

Financial stability was one discussed factor, which assumingly had similar responses. When a crisis hits, deep pockets enable better recovery due to better ability to make temporary changes and investments, and get additional loans when needed. If finance is weaker already before the incident, there is a danger of snowball effect that then many other things may become worse just because of the incident and lack of resources. FOOD1 admits that without the support from the group the company would have gone to bankruptcy. Financial deficits slowed down the recovery.

There can also be issues when returning to business with prioritization of the orders, because there may not be adequate number of finished products to fulfill the orders. Knowing the most important customers could help in prioritizing so that the negative impacts would be minimized with respect to the most important customers.

Communication should be considered carefully so that the internal and external information would be appropriate and timely. METAL2 raised the idea that the information should be communicated fast but it should be already somewhat analyzed. Too fast communication tends to be vague, but postponing the informing can allow the interested parties such as customers hear about the issue from third parties. Those are not the preferred sources of that kind of information for the closest partners.

## 7.7. Reliability of the results

The findings of this chapter are mainly based on the theme interviews and to some extent based on the questionnaire. The samples are limited, and this type of work cannot take very comprehensive approach to these topics that have been covered in this thesis. However, the reliability of the findings could be said to be fair because there are considered two very different industries with two different operators so that the similarities and differences between industries and companies could be distinguished better.

The study includes so many factors that play significant roles in business interruptions that even though the analyses include findings that relate to other factors, it could be analyzed even much more deeply. However, the findings show directive evidence of the business interruption phenomena, and provide a basis for future research.

# 8. DISCUSSION

Although the results were discussed shortly already in the empirical part, the deeper discussion will be presented in this chapter. Firstly, the results are compared to the research objectives to see whether the study was successful with respect to the purpose of this work. Then, there are comparisons of the results of this study with earlier findings. There are a few things to compare, albeit the previous studies have had slightly different topics and scopes. Thirdly, there will be a short discussion of the significance of the results before presenting the future research areas, which are quite numerous.

## 8.1. Results in terms of research objectives

The scientific study of business interruptions is minuscule, and this study aims at bringing the topic under deeper discussion and raising the concern of the consequences of business interruption incidents. Because the topic is diverse, and getting a decent view of the different aspects of this study, this work does not go very deep, but rather gives a basic understanding of the theories and concepts as well as provides empirical evidence for the research questions.

I had five research questions in this thesis. Firstly, I tried to figure out whether the extant theory would provide a method for analyzing business interruptions and resilience, but the result was that even a proper theory and basis for this topic was difficult to find. The only model found was not suitable nor established, which left the need for another model remaining. There were, however, some models related to risk mapping, but combining comprehensiveness and simplicity seems a challenge to be overcome. Too complex model hides the insights while too simple models do not provide that much help. This study presents a model for mapping risks, which tries to keep it simple enough to use but consider two different sides of the risks. They are sources and classes of the risks forming a $4 \times 3$ matrix. On top of that, the model includes analyses on the adequacy of the different risk management areas in terms of put efforts and the risk severity. A third part of the model is analyzing the resilience and vulnerability with respect to 15 most critical factors related to resilience in the writer's opinion.

The second research question was determining the usability of the model of this thesis. The whole framework is a product of the writer based on the literature and findings presented in the theory part. It would have been recommended to evaluate the case companies of this study with this model, but because it appeared that the model would have required deeper knowledge of the companies and their operations, and the schedule of the study did not allow a conduct of further analysis, this question remains somewhat unanswered. Regardless of this, the model can give at least something new to consider even though companies would already have their own models and methods for risk, resilience, vulnerability, or business interruption evaluation. However, even this Risk Readiness Evaluation Tool is deficient and would need testing and refining in order to become a trustworthy and useful method for risk management and resilience evaluation.

Third research question seeks answers to the determinants of the size of the business interruption losses. According to the questionnaire, the worst factors that affected negatively the size of the loss were the prolonged impacts of the incident, unpreparedness, the target of the event, spreading of the damage, and the actions made by external parties such as officials, competitors or other facets. The factors, which helped to reduce the losses, were fast reacting, available excess capacity, preparedness, continuity plans, and redundancies related to parts, materials, machines etc. Other factors that were discussed more deeply with the interviewees were quality problems, relationships with partners, dependencies, reputation, and timing of the incident among a few others. Although there were some factors present more frequently than others, the loss events are so unique that it is difficult to find universal patterns to the factors behind losses.

Fourth research question aims at finding solutions to avoid business interruptions. One root cause for business interruptions is the trend of reducing working capital and optimizing the operations to work without buffers. However, this vulnerability, which is rather a condition than a specific risk, is a great reason for companies facing business interruptions and being unable to withstand and recover from interruptions quickly. Companies could prepare for the adverse events by creating a business continuity plan (BCP), which has many benefits when crises emerge. A BCP reduces and increases the risk recognition and assessment, decreases the impacts of the events, and helps in recovering from losses to the original condition. Third entity related to this question is the design and structure of sourcing and

operations. The amount of suppliers for different materials, parts or products is a disputed matter. Multiple and single sourcing both have pros and cons. However, when discussing the avoidance of business interruptions, multiple sourcing is 'the safe' option because the supply is not dependent on only one supplier. By the same token, when the supply has been divided into several shares, the probability of failure by any of those suppliers grows as the number of suppliers grows, which makes the disruptions more frequent but less critical. But because the sourcing strategy is an interest of also many other people than risk managers, this viewpoint is not the one and only that matters. The fourth major topic within this question is supply chain risk management, which considers vulnerabilities and risks within the supply chain. A disruption for one party of the chain can cause interruptions for many other parties. Therefore a proper assessment of supply chain risks should be made so that preparedness could be higher and the impacts of such glitches minimized.

This thesis answers one more research question regarding returning to markets after the interruption. Resilience, which is defined in multitude of ways, is one important component of risk management, but its significance is highlighted especially what comes to recovery from losses. Resilience can be obtained very diversely, and each way has properties that fit best to specific vulnerabilities. The most common ways to create resilience is to have redundancies and flexibility. Agility and postponement are useful strategies that give more time to make estimates being responsive and quick, but the utilization of these require capable supply chains and certain characteristics of the operating environment and products in order to be most applicable. Complexity is a noteworthy aspect, which can make operations risky and costly. These factors are mainly operational and 'hard' factors that enable better control of the operations when part of the facilities are down. 'Soft' factors relate to culture and cooperation with partners, which should definitely not be neglected, because they are making the everyday business and operations more resistant to disruptions and shocks.

## 8.2. Results compared to earlier findings

Many topics covered in this study were challenging to match with the earlier research because this study takes a wider perspective to business interruptions than the material.

Furthermore, when the articles usually have a narrow topic with deep analysis, this study combines the topics in the articles. Making comparisons to earlier findings with this broader view at hand is not simple, but the following paragraphs reveal the most noteworthy findings and comparisons.

Risks that companies face are generally quite well recognized, but capital limitations constraint the effective risk management (Silva and Reddy 2011). The same situation prevails in the case companies of this study. They recognize that there are certain risks and vulnerabilities but their resources are scarce and not all suitable methods can be applied. Silva and Reddy (2011) have also found out that supply network disruptions deteriorate the companies' ability to keep their promises towards customers, which was seen by the metal case companies particularly well.

The findings made by Stump (2010) and Glendon and Bird (2013) are fairly consistent with the findings from the empirical material about the consequences of business interruptions. Even though Stump and Glendon and Bird had somewhat different findings, the empirical content was pretty much covered in either of the sources. There would be many factors to list, but to mention a few of them, direct financial losses, bruised partnerships, employee concerns, and reputation were mentioned both in theory and practice. Some empirical findings were not covered in the theory, such as ineffective use of resources and lost routines as well as increased gap between competitors due to the regression of the hurt companies and the continuous improvement by competitors. These should be included in the future research.

Disruptions occur quite frequently and most of the companies get involved with them sooner or later according to both the questionnaire of this study and Glendon and Bird (2013). The latter shows that about 75 percent of the surveyed companies have faced a disruption within a year, while the questionnaire sports a figure of 89 percent, but without a specific time limit.

The table below compares the results of the CFO Research Services (2009) and the questionnaire regarding different events and the distribution of the loss severity. The small differences in the setups between these two results are that CFO Research Services uses a 5-year span during which the surveyed companies have faced disruptions while the

questionnaire uses 3 years instead. Moreover, the risk categories have been slightly changed so that they would fit better to the target companies. Correlation between identical risk categories – omitting logistics and supply chain disruptions and fire – is 95.9 %. The figures for substantial and some negative impacts are in most cases greater in the CFO Research Services' sample, and the reason can be longer timespan and the demographics of the surveyed companies. The questionnaire sample represents the lower half of the revenue scale used by CFO Research Services, and bigger companies tend to be more prone to disruptions.

**Table 8.1 Comparison of the impact distributions for different risk categories**

| | CFO Research Services (2009) | | | Questionnaire | | |
|---|---|---|---|---|---|---|
| | Substantial | Some | Little or no | Substantial | Some | Little or no |
| **Disruptions in logistics/supply chain** | 8/11 % | 46/42 % | 45/46 % | 22 % | 39 % | 39 % |
| **Natural disasters** | 10 % | 35 % | 55 % | 5 % | 16 % | 79 % |
| **Machinery breakdowns** | 4 % | 38 % | 58 % | 11 % | 37 % | 53 % |
| **Fire** | - % | - % | - % | 11 % | 11 % | 79 % |
| **Reputational damage** | 7 % | 24 % | 69 % | 0 % | 11 % | 89 % |
| **Security/IT threats** | 5 % | 25 % | 70 % | 0 % | 22 % | 78 % |
| **Terrorism or vandalism** | 4 % | 16 % | 80 % | 0 % | 0 % | 100 % |

Researchers claim that companies are reducing suppliers rather than increasing them because the business environment has become so competitive that it is more efficient to have fewer strategic partnerships than several suppliers (see Berger and Zeng 2006, Blome and Henke 2009, and Hallikas *et al.* 2004). The discussions with case companies (which all have faced at least some sort of incident) showed that the number of suppliers may have been reduced earlier down to few, but now they are all but decreasing them. Once incidents have occurred, the mindset has changed to be more proactive and relying on more suppliers. However, companies without severe losses may still think that they will survive with current amount of resilience.

The incidents faced by the case companies have been mostly low or medium impact losses with varying probability to occur. As Sheffi (2005, p. 57) and Asbjørnslett (2009, p.32) bring up, companies are more vulnerable to rare incidents with high impacts because they can learn about the more frequent events, which is the case for FOOD1 and METAL1.

However, although the fire was not the first one FOOD1 experienced, they encountered a severe loss, because the damage was so large.

Earlier literature does not have data abundantly about how much cooperation happens in reality between business partners and what sort of information exchange it includes, but at least the benefits of collaboration have been studied well. The questionnaire revealed that a sovereign majority collaborates within their supply chains but only a little. The benefits, however, have not been as high as promised, but maybe the intensity of the cooperation should be higher before the benefits realize to full extent.

## 8.3. Significance of results

Although the research of this area of business is in its infancy, this study illustrates very clearly that companies and other practitioners should pay more attention to the risks and the control of them, because in worst cases the destruction can be physically, mentally, and financially severe, long-lasting and even terminating. Unprepared companies that are generating big profits can be struck by a hazard, which can lead the once thriving company to a bankruptcy if the consequences of the incidents cannot be limited and the decision-makers have not created resilience or prepared plans for business continuity. This study reveals some of the focus points about vulnerability, resilience, and business interruptions that should be considered.

As a thesis this may lack scientific requirements to be adequately reliable piece of theory, but this surely can open discussion and thoughts among researchers and practitioners who are interested in this topic. The contribution of this work to the defective theory is that the scattered elements related to business interruptions have been filed under wider themes that have been studied as research questions. Moreover, this study provides a tool for analyses of risk management practices including resilience, which is a relatively new component in the field of risk management. Resilience has been studied fairly well bringing something fresh and new to the risk management research. The created tool can be useful for measuring the ability of companies to withstand when adverse events arise, and even though a company already had an instrument, this one can pinpoint additional areas that should be added to the existing tool in order to make it even better.

The empirical part of the thesis was supposed to be more comprehensive, but several cancellations by potential interviewees made the sample relatively small. Fortunately, it includes different companies operating in different industries, still having two companies from both industries making the findings related to industry-specific things stronger. The fact that there are two interviews for some case companies make their analyses even better, but those interviews with only one representative from the company were longer making the discussions deeper. The questionnaire also suffered from lack of respondents, but similarly, it provided quite useful results. The distributions for the questions could still reveal decently well which practices are used in companies and which not.

A fact that makes the results of this study significant is that in the extant literature the problems faced by companies are usually supply chain glitches instead of incidents, which interrupt the operations for longer periods. If the smaller disruptions induce fairly bad consequences for the performance, the consequences from greater business interruptions should be even worse. Therefore, the findings from the theory may be understated compared to real consequences of large scale business interruptions. Getting this to wider analysis would be a great upgrade to the theory.

## 8.4. Future research topics

Since this topic is pioneering work in academic literature, it provides a number of topics that remained unanswered. Even though many of them could have been studied in more detail without big challenges, other constraints such as the size of this study, and time created obstacles that left them to future research topics. The following paragraphs provide some of the possible areas of studying.

If this work would have been broader at scope and length, an additional research question would have been the dilemma between minimizing costs being simultaneously resilient. This is a big concern for companies, but interview respondents could not provide direct answers. Nowadays business is competitive in most industries and costs must be in control so that it is profitable. The more costs are reduced the more usually the company becomes vulnerable, which again increases the risk of obtaining the massive disadvantages and expenses of business interruptions. Even though this topic has been covered in this study,

future research could find out how companies could find a balance between costs and resilience, and how large an impact would an increase in resilience have on corporate finance in the long term.

Dependencies have been studied already to a fair extent, but it would need a better focus on business interruptions and risks as well. As presented in the empirical part, two major elements behind dependencies related to risks are (1) who the company is related to, and (2) how the dependency relates to the processes. On top of these, there might be also other important factors that could be taken into discussion such as severity and criticality of the dependency, and the impact of alternative suppliers on the dependencies in the future.

There is a myth in insurance industry that massive business interruptions would cause bankruptcies, and Gosling and Hiles (2009) have collated estimates of the probability, but they seem somewhat unreliable and so undecided that it is too vague to draw strong conclusions from them. However, if there was stronger evidence that severe business interruptions really lead to bankruptcies, as provably happens, it could resonate better among companies and end up in better risk management.

Timing of the incident was a topic, which was discussed but it was only a minor aspect of this topic, so a deeper analysis and research could reveal more remarkable findings than this study. The small evidence by the case companies showed that as METAL2 suffered when it was calm on the market, it did not suffer as much as FOOD1. However, business interruption losses derive from so many factors that taking only this aspect into consideration is challenging.

Another common concern throughout the thesis has been the reconciliation of theory and practice, because the topics in the literature and the concerns of the company representatives were somewhat different. Theory considers conceptual problems such as vulnerability, complexity, supply chain disruptions and many other mentioned problems, while practitioners are worried about workers' safety, hot work risks, key machine breakdowns, and such practical things. Naturally, there can be found topics in both groups, but the mutual topics are quite few.

# 9. CONCLUSIONS

Studies show that disruptions will be a matter of practically all companies nowadays, and therefore this topic should be taken seriously. The consequences of business interruptions are multiple and theory should get more attention to business interruptions in general instead of supply chain disruptions which is very popular topic already.

The theory lacked a good framework for analyzing business interruptions and evaluating the level of risk management, vulnerability and resilience, so this study introduces a new Risk Readiness Evaluation Tool, which takes risks, risk categories, several factors of resilience and vulnerability into consideration. The usability of it remains uncertain, but it is very versatile, because it can measure the readiness to face risks regarding different functions, locations, business areas, business units and so forth. The other three research questions are concluded in the following parts.

## 9.1. Business interruption risks and incidents

Companies should understand, and in many cases they do understand, the importance of their own risk management, including resilience, and loss prevention practices in order to avoid business interruptions. The major obstacle is putting the knowledge into practice. Currently, the greatest hindrance seems to be a lack of resources stemming from prioritization of other activities over risk management. The objective of risk management is to enable the core activities of the company, and therefore the other activities closer to the core are often seen more important than risk management. Additionally, small margins of the case companies may cause reluctance to invest in costly risk mitigation strategies, which often ends up vulnerabilities that are not covered by resilience.

Even though insurance may cover a major share of the losses for the indemnity period, the lingering effects of the loss such as lost customers, and damaged reputation and relationships with partners can cause indirect losses that insurance companies are not covering. Overreliance on insurance can expose the companies to the fatal consequences of the interrupted business instead of proactively managing and mitigating risks. Still, insurance is an important investment for companies in order to avoid large losses for their

part, but it is just one part of the whole picture. The optimal situation would be that companies would sharply evaluate their risks and prepare plans to control them, and only then invest on the insurance, when they know more about their risks and vulnerabilities, and so that coverage, indemnity period and other specifics could be set at right levels.

Dependencies play a remarkable role in incidents because the business network is complex and relationships and partnerships become stronger. The failure of any party in the network has some kind of an effect on others; the closer and the stronger the relationship, the more severe the impact of the failure is. Therefore the important factors determining the size of the loss are the proximity of the dependency in the network, and the importance of that node in the operations.

## 9.2. Prevention of business interruptions

Business interruption is a more frequent nuisance for vulnerable companies than for resilient companies. Typical examples of vulnerabilities are strong dependencies, minimized working capital, reduction of suppliers, complexities, which mostly derive from the increased cost competition and subsequent trend for just-in-time and lean strategies. These vulnerabilities can be reduced by investments in resilience. Free capacity, inventories, agility, deep collaboration with partners, visibility within supply chain, flexibility in production and sourcing, and continuity planning among several other means are common ways to improve resilience and business continuity.

Sourcing and production strategies raise much discussion in the literature, and this topic has a lot to do with business interruptions – mostly in form of shorter interruptions due to inability to deliver. Single sourcing is cost effective in terms of administration and managing supplier relationships, simple and enables easy quality assurance, whereas multiple sourcing enables lower prices through competition, smaller dependencies, and flexibility in sourcing (Blome and Henke 2009, p. 127). Both strategies have pros and cons, which should be fitted to the overall strategy of the company. There should not be only one supplier particularly when the relationship is not strong, but neither many suppliers with deep relationships because otherwise risks or costs, respectively, are unnecessarily high (Sheffi 2005, p. 215).

After all, risk management should support the core activities of the company, and therefore the use of risk management practices should be economically viable and justified. On the other hand, proper calculations including all aspects of risks and their consequences should be included lest the calculations would provide false information and lead to bad decisions. However, risks being uncertain events are not the most attractive targets of the investments for top managers because they are usually rare and do not regard us.

## 9.3. Creating resilience

Preparedness for risks is one of the most important things related to the size of the loss. If it lacks, it increases the loss, and if the company is prepared, it can reduce the size of the loss very much. The level of resilience and preparedness could be at higher level because avoiding adverse events and their impacts save companies from the direct and hidden costs of disruptions and following interruptions. Even though resilience has its costs, those costs can be controlled unlike the costs related to mishaps.

The definition of resilience is scattered, which also makes its research more difficult because different researchers approach the concept differently. The more there will be studies on resilience in the future the better basis it can provide for paradigms and findings that could have a strong impact on practitioners, which is now still in its infancy.

Vulnerabilities reign when redundancies have been reduced in the midst of harsh competition. When vulnerability is consciously accepted by using strategies that increase vulnerability and reduce resilience, it is only about the realization of risks that will determine whether the company will survive well or receive adverse consequences from incidents.

Redundancies are pivotal to ensure better continuity, but in systems' context, redundancies are threats. They are not always straightforward, and finding a good match with operations and suitable methods for resilience is a demanding process. The operational specifics will determine whether inventories, capacity, flexibility or other methods are the best alternatives to increase resilience.

A business continuity plan helps companies to prepare for and recover faster from crises. It is much better than diverse recovery or other crisis plans that are plentiful, but generally having any plan is better than having no plan at all.

Amidst of the risks surrounding companies it is recommended to collaborate and share information in order to get relevant information faster. Collaboration can support companies to perform better and prevent risks together. Invisibility of supply chains make the operations harder, and complex networks disable structured collaboration approaches despite the willingness to cooperate. After all, good and effective collaboration ends up in resilience and better risk management, so it is worthwhile to put efforts on its execution. Vachon and Klassen (2002) add that information exchange between companies can reduce complexity giving even more reasons to have conversations with partners.

Dependencies certainly affect the size of the loss, but the definitive factors are the intensity and importance of the dependency. Reduction of redundancies and suppliers has led to stronger dependencies on suppliers and machines. Furthermore, reduced amount of suppliers have made the existing relationships strategic partnerships that are more risky but however, encourages better cooperation, which could – and should – include collaboration on risks.

While damaged companies regress during business interruptions and have to reorganize their operations and resources, other companies can continue their business development and routines, which expands the gap between hurt and unhurt companies. The effects of this gap grow as the duration of the business interruption prolongs. Therefore, the faster recovery is essential for the continuity of the business after the adverse events. Empirical material provided following means to recover faster: having inventories, communicating tightly with partners, previous experience from such events, rapid actions and reconstruction, and high product quality, which attracts the customers back after the downtime.

## 9.4. Managerial applications

Practitioners should take this topic seriously, because too many cases have shown that ignorance towards risks and vulnerabilities have led to lengthy periods of negative

consequences of the event. Moreover, although knowledge of this topic would be good, it must be converted into concrete actions before it protects from the negative impacts. The most severe events tend to have so wide effects on business that companies struggle with survival from the damage in the long term. At worst cases companies never recover, which is terribly high price to pay.

From risk perspective, having multiple suppliers would make the failures' impacts smaller, but more frequent. It would be more reasonable to rely on many suppliers than being dependent on only one source, but in some cases multiple suppliers may not give as much safety as normally. However, because managers have to think many different aspects, it is realism that having multiple suppliers is unaffordable from their point of view. Single sources become strategic partnerships and their significance grow for the company. In Sheffi's (2005, p. 215) opinion, one supplier with deep relationship would be acceptable, but this is not indisputable matter in the literature. Fortunately, deeper relationships encourage better cooperation, which relieves the vulnerability from single supply situation, but adding suppliers would make the sourcing more reliable. Whichever is chosen as the sourcing strategy, it should fit to the overall strategy and the risks taken into control properly.

Adding resilience is always beneficial for the risk management and especially for the shortening of the recovery period. However, making it wisely, the managers should know the vulnerabilities before adding resilience so that the right and most useful methods of resilience would get the priority. Resilience is not cheap, and therefore a careful analysis of vulnerabilities and resilience would help to make better decisions. Too small resilience is risky and higher than necessary resilience erodes profits (Pettit *et al.* 2010).

Culture is only the reality of the way the things are done in the company. Getting the right risk management culture requires a lot of work to root the safety mindset into every employee's mind, because even if one or few employees disregard the guidelines, it can cause vast damage to the company by their reckless routines. Seeding the right culture may take much time but it is effective and inexpensive way to increase resilience.

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# APPENDICES

## APPENDIX 1. Theme interview questions.

The following questions were discussed in the interviews but each interview had different contents. Therefore, some questions were not relevant for some respondents and thus, were not asked, whereas additional questions were sometimes asked to get better understanding of the topic.

### General questions

What was your position during the incident, and what was your role related to the handling of the incident?

Did you have recognized the risk, which led to the incident?

With which means did you have prepared for that risk at site and group level?

What was the immediate impact of the incident?

Was the event a surprise?

What actions were taken right after the incident at site and group level?

How long was the technical loss period? (From the incident until restart of the production)

How long was the financial loss period? (From the restart of production until reaching the budgeted levels)

### Factors affecting the size of the loss

What factors affected most the size of the business interruption loss?

What were the worst consequences of the loss?

Do you have business continuity plan, and if yes, what stage it is at? Did it exist at the time when the incident happened? What were the most important benefits of it?

What are the most important factors leading to property damage or business interruptions? What other factors could possibly induce business interruptions?

**Protection against business interruptions**

Have you changed your processes, suppliers or risk management practices after the incident? What changes have you made? What are the best means to improve business continuity in the future even more?

Have you decentralized your operations in order to avoid risks?

How do you quantify risks and evaluate their criticality?

Do you find being vulnerable if you have only few suppliers? How has it appeared?

How have you found a balance between production cost minimization and resilience?

How do you evaluate suppliers before starting the cooperation with them?

**Cooperation**

What sort of information do you exchange with your partners in order to mitigate business interruptions?

What sort of cooperation do you have in your supply chain?

What have been the most important benefits from cooperation on risk management?

**Supply chain risk management**

Do you know who are your critical suppliers and how much their disruptions affect your profits?

Have you mapped the critical parties of your supply chains from end to end?

Has the supply chain management integrated into ERM or other risk management processes?

Do you keep a record of supply chain disruptions in order to avoid future disruptions?

Do your first tier suppliers have a tested and functioning business continuity plan (BCP)?

Do you discuss risks with your strategic suppliers?

**Returning to markets**

What factors eased/made it difficult to return after the business interruption?

What was the slowest factor in the recovery process?

How important for the recovery process is to be financially healthy and stable?

Did your competitors get significant advantage from your incident?

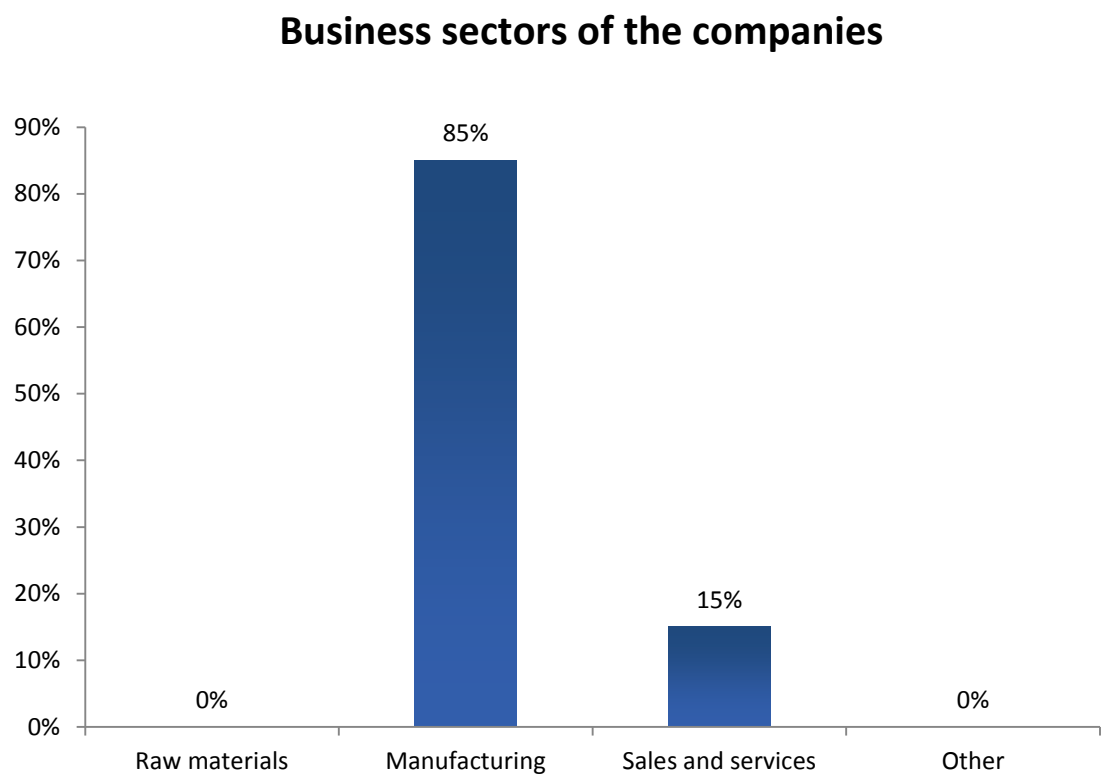
To what extent and for how long did the business interruption affect your market share and the position in the market?

To what extent and for how long did reputational damage affect sales and do they still affect somehow?

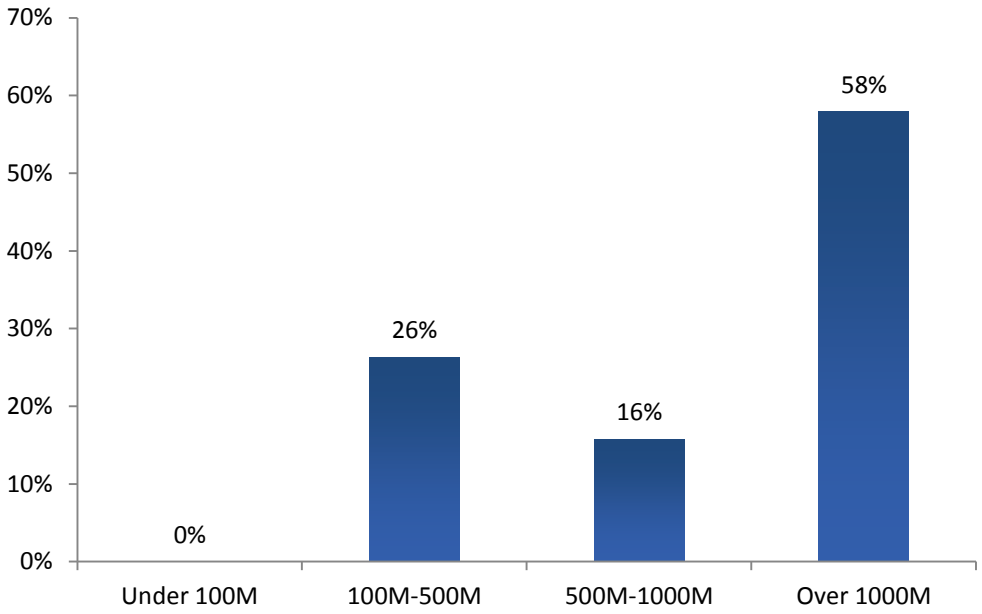
**Conclusions**

What were the most valuable lessons you learned related to business interruptions?

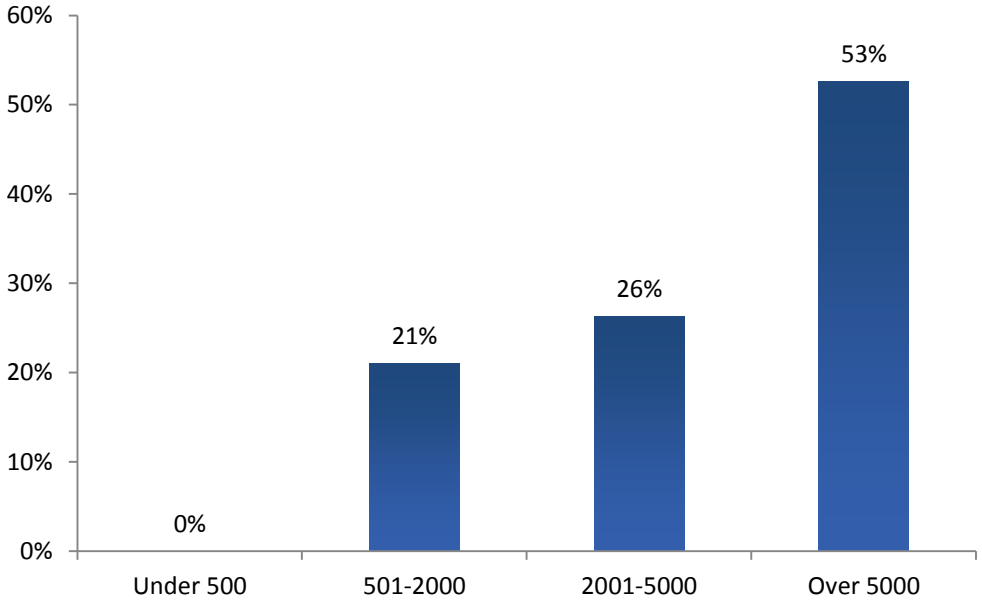
**APPENDIX 2. Questionnaire results.**



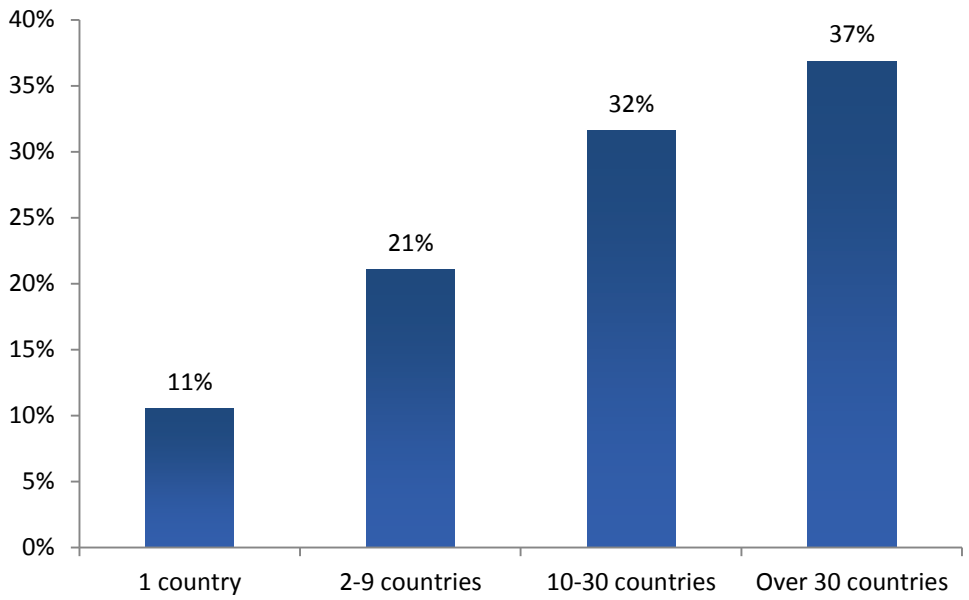
## Group revenues (€)



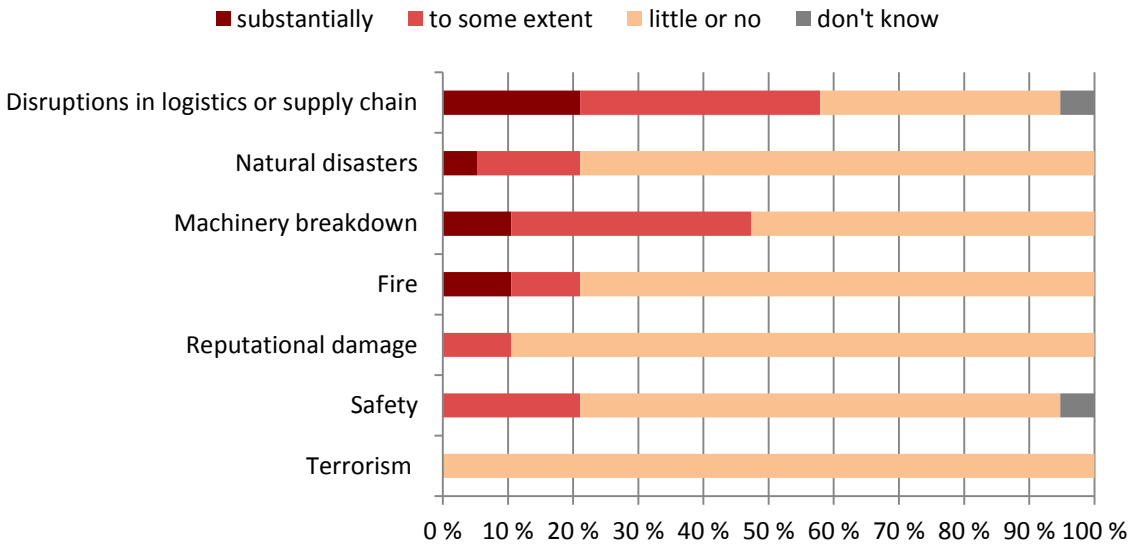

## Number of employees



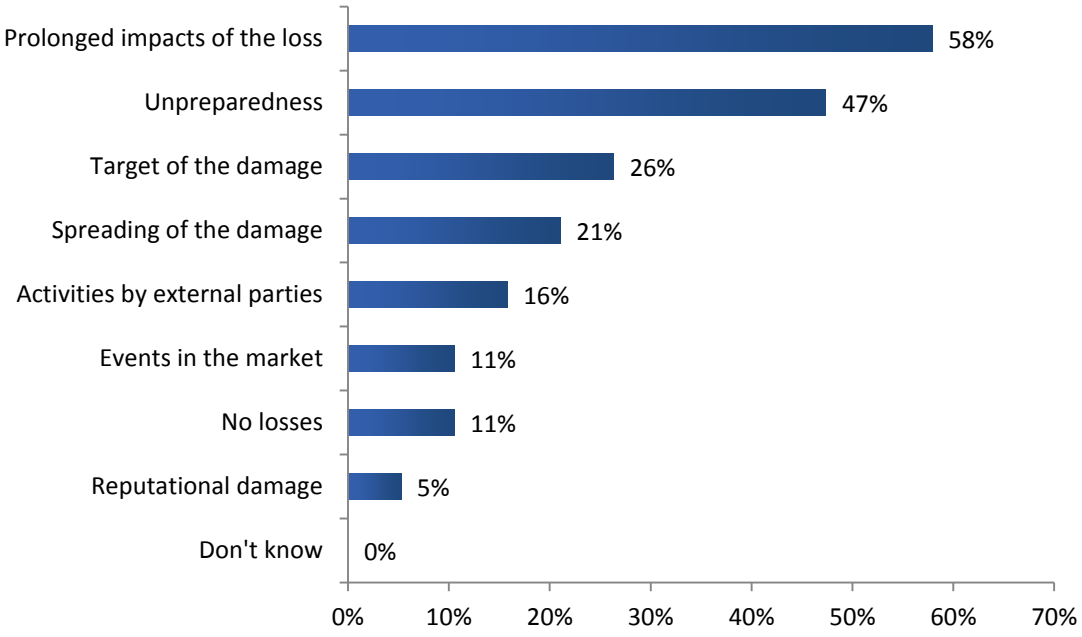
## Geographical dispersion of activities



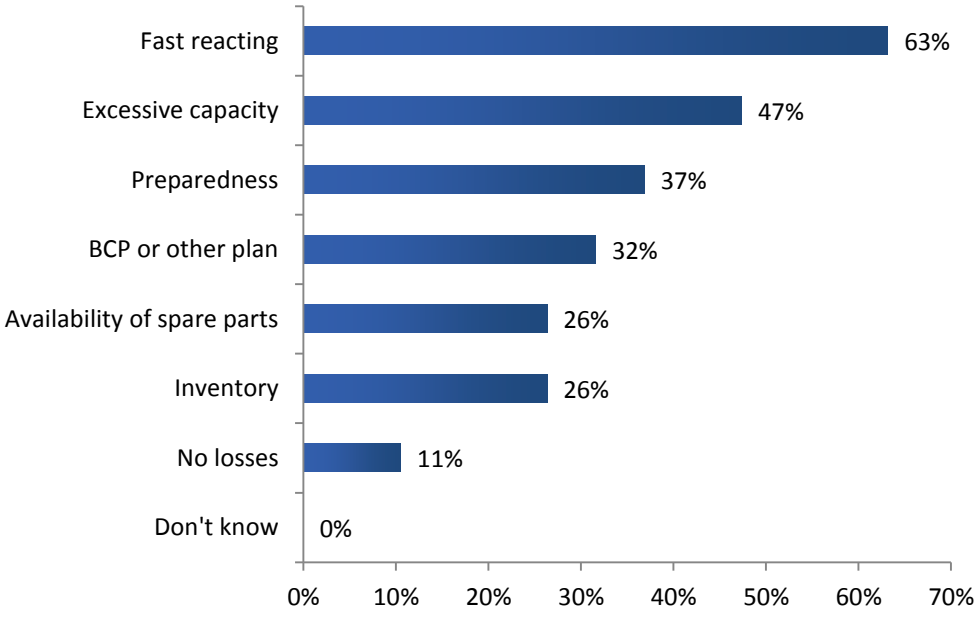

## Impacts of different risks on finance



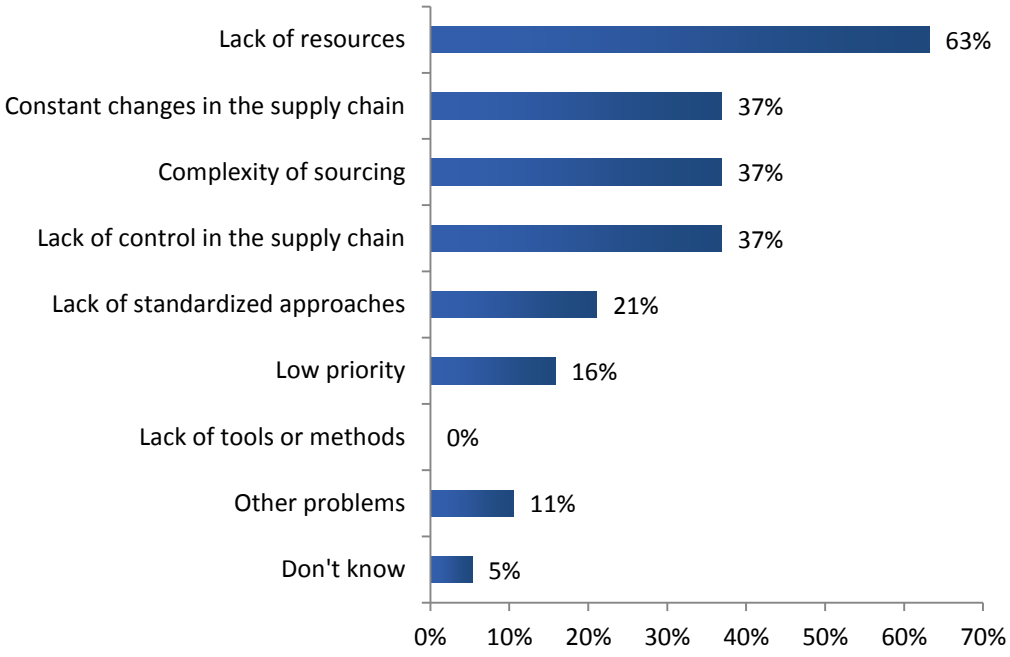
## Factors affecting negatively the size of the loss



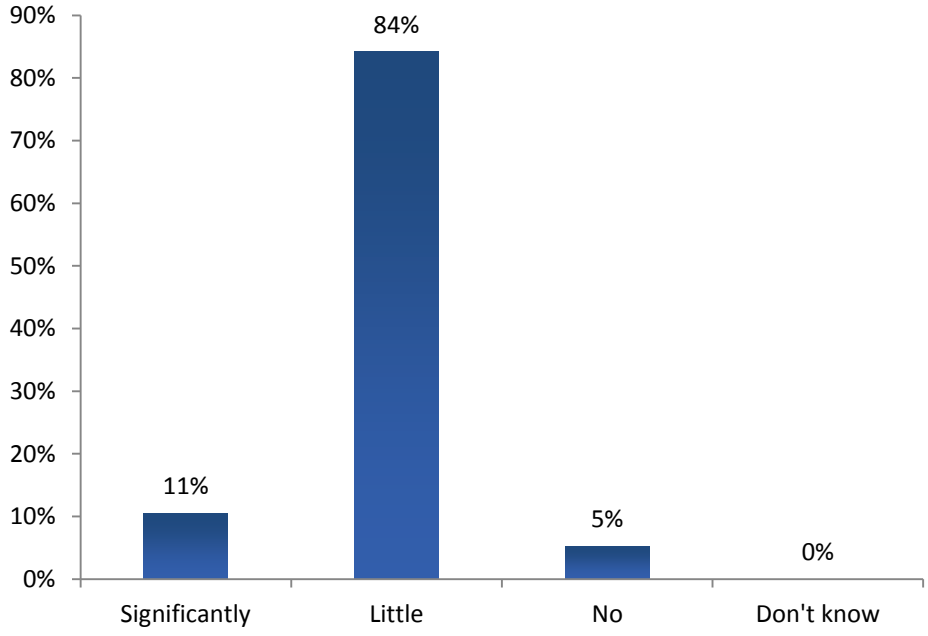

## Factors affecting positively the size of the loss



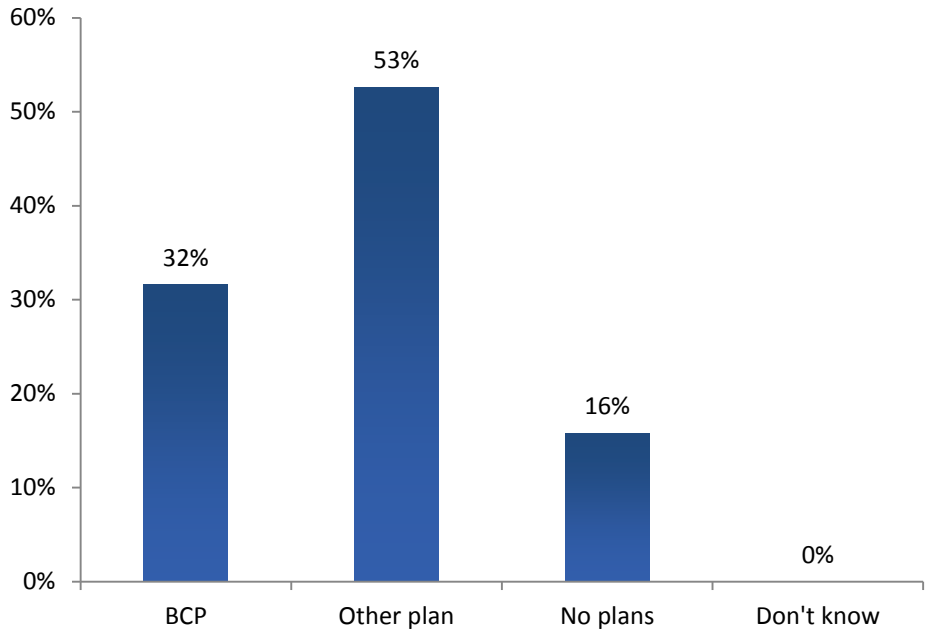
## The most important factors hindering the cooperation in SCRM



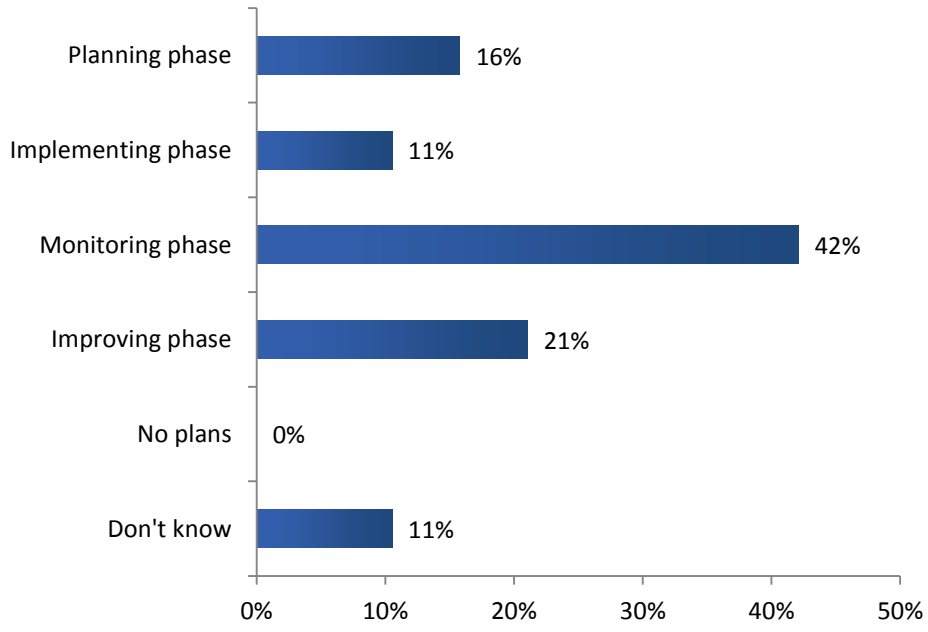

## The level of cooperation in SCRM



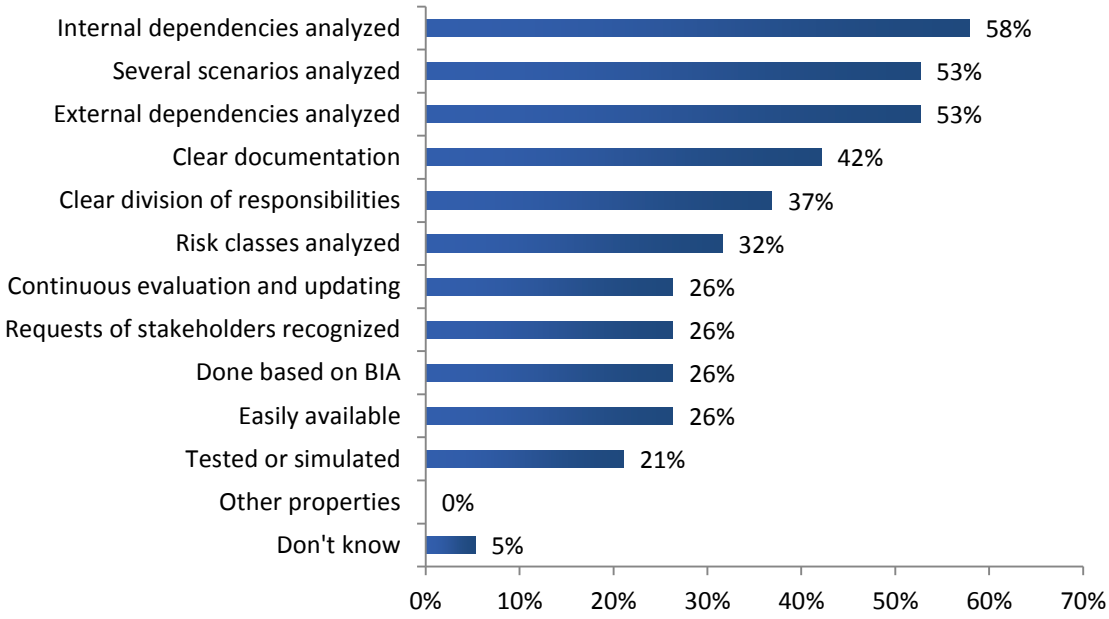
## Types of continuity plans used




## The stages of the continuity plans



## Properties of continuity plans




## Methods of resilience used in companies