A Disaster Recovery Planning Guide

- On how to mitigate the supply chain disruption risks of a totally destroyed central warehouse

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Abstract

The development of modern enterprises goes toward more complex supply chains with many links and worldwide transportation. The trend of using centralized warehousing as logistic setup has grown more popular during the last years. This development has created new risks and implied increased vulnerabilities for many enterprises. To manage these issues the area of Business Continuity Management has grown more important.

This thesis contains an action oriented Disaster Recovery Planning (DRP) Guide, which aims to ensure the continuity of critical activities in the event of a disaster and reduce the disruption of the company's business. The guide is mainly applicable for a central warehouse but can be applied on other logistic setups.

The foundation of the guide comprises studies of literature, a case study of DeLaval's central warehouse in Hamburg and some documented mini cases. The preliminary guide was tested on three experts, which resulted in some adjustments to form the final DRP-Guide.

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Some of results of the thesis have been applied in the reality. The DRP-Guide was used to develop a Disaster Recovery Plan at DeLaval's central warehouse in Glinde. This was sort of a test of the applicability of the guide and the process highlighted the guide's strengths and weaknesses.

Hamburg 2008-11-18

Linus Hellman Magnus Karlsson

Summary

Today's society is based on globalization, specialization and mass-production. The development of modern enterprises goes toward even more complex supply chains with many links and worldwide transportation. A number of severe company events caused by supply chain disruptions have occurred during the recent years, which illustrate that a single disruption in the supply chain can easily have domino effects and cause devastating impact. To handle these new upcoming risks the field of Business Continuity Management (BCM) has grew more important during the last years. One company that has highlighted the need for BCM and continuity strategies is DeLaval, which is the assigner of the thesis.

The purpose of the project is to contribute to the knowledge on how disruption risks in a supply chain with just one central warehouse can be effectively managed. The objective of the thesis is to develop a Disaster Recovery Planning (DRP) Guide which helps to generate new alternatives, for the delivery of products and services from supplier to end customer.

Studies of literature were carried out within BCM and DRP to get a comprehensive knowledge within these areas. A case study was conducted at DeLaval's central warehouse in Glinde with the purpose to establish an understanding of logistic and organizational factors. Some documented mini cases was also studied to highlight the relevance of the subject. Based on these inputs a general DRP-guide was developed. The guide was tested at three experts, two external risk management consultants and one manager at DeLaval's head quarter. The received feedback was taken into consideration to make some adjustments and form the final guide.

The last chapter comprises a discussion regarding how the purpose is fulfilled and the objectives are met. The application of the DRP-Guide is further discussed and possible areas for future research are lightened. The outcome of the thesis is the developed DRP-Guide, which aims to manage disruption risks in a supply chain with just one central warehouse. The guide is action oriented and focuses on how to ensure the continuity of critical activities in the event of a disaster and reduce the disruption of the company's business. Though the guide is developed especially for a central warehouse, companies that use other logistic setups should also be able to benefit from it.

Sammanfattning

Dagens samhälle är baserat på globalisering, specialisering och massproduktion. Utvecklingen av moderna företag går mot allt mer omfattande och komplexare flödeskedjor med många länkar och världsomfattande transporter. Ett antal allvarliga företagshändelser orsakade av avbrott i flödeskedjan har inträffat de senaste åren, vilket illustrerar att ett enskilt avbrott i flödeskedjan lätt kan få dominoeffekter och orsaka förödande konsekvenser. För att hantera dessa nyuppkomna risker har Business Continuity Management (BCM) blivit allt viktigare de senaste åren. Ett företag som har belyst behovet av BCM är DeLaval, som är uppdragsgivare för den här rapporten.

Syftet med projektet är att bidra till kunskapen om hur avbrottsrisker kan hanteras i en flödeskedja med enbart ett centrallager. Målet med projektet är att utveckla en Disaster Recovery Planning (DRP) Guide, som kan bidra till att generera nya alternativ för leverans av produkter och tjänster från leverantör till kund.

Litteraturstudier genomfördes inom BCM och DRP för att få en heltäckande kunskap inom de områdena. En fallstudie genomfördes på DeLavals centrallager i Glinde med syftet att skapa förståelse för logistiska och organisatoriska faktorer. Även några dokumenterade mindre fallstudier studerades för att belysa ämnets relevans. Baserat på de här källorna utvecklades den allmänna DRP-guiden. Guiden testades på tre experter; två externa riskhanteringskonsulter och en chef vid DeLavals huvudkontor.

Slutet av uppsatsen består av en diskussion om hur syftet och målen är uppfyllda. DRP-guiden tillämplighet diskuteras vidare och möjliga områden för framtida forskning är belysta. Resultatet av uppsatsen är den utvecklade DRP-guiden, vilken syftar till att hantera avbrottsrisker i en flödeskedja med endast ett centrallager. Guiden är handlingsbaserad och fokuserar på hur kontinuiteten av kritiska aktiviteter i händelse av en katastrof kan garanteras och hur avbrottet i företagets affärsverksamhet kan reduceras. Trots att guiden är utvecklad speciellt för ett centrallager, bör även företag som använder andra logistiska upplägg kunna dra nytta av den.

Definitions

Business Continuity Management

A holistic management process that identifies potential impacts that threaten an organization and provides a framework for building resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value creating activities (DRII, 2008).

Business Continuity Plan

Process of developing and documenting arrangements and procedures that enable an organization to respond to an event that lasts for an unacceptable period of time and return to performing its critical functions after an interruption (DRII, 2008).

Crisis

A critical event, which, if not handled in an appropriate manner, may dramatically impact an organization's profitability, reputation, or ability to operate. Or, an occurrence and/or perception that threatens the operations, staff, shareholder value, stakeholders, brand, reputation, trust and/or strategic/business goals of an organization (DRII, 2008).

Disaster

A sudden, unplanned catastrophic event causing unacceptable damage or loss. More specified a disaster is an event that compromises an organization's ability to provide critical functions, processes, or services for some unacceptable period of time (DRII, 2008).

Disaster Recovery Plan

The management approved document that defines the resources, actions, tasks and data required to manage the technology recovery effort. This is a component of the Business Continuity Management Program (DRII, 2008).

Enterprise Risk Management

Enterprise risk management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risks to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives (COSO, 2003).

Focal Unit

Focal unit means the individual firm in the supply chain from the perspective of which the supply chain flow risk issues are seen, interpreted and acted upon (Paulsson, 2007).

Risk

Kaplan and Garrick (1981) define risk as a triplet that answers the following three questions.

(i) What can happen?

(ii) How likely is it to happen?

(iii) If it does happen, what are the consequences?

The answers to these questions can be expressed with the triplet of scenario (S), likelihood (L) and consequence (X). The risk is the sum of all scenarios, the likelihood that they occur and the consequence they cause.

Supply chain

The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer (Christopher, 1998).

Supply Chain Disruption

A supply chain disruption can be defined as an interruption in the continuity of the normal supply chain flow with a negative result impact (Paulsson, 2007).

Supply Chain Risk Management

The identification and management of risks within the supply chain and risks external to it through a coordinated approach amongst supply chain members to reduce supply chain vulnerability as a whole (Christopher, M. and Peck, H., 2003).

Acronyms

BCI	Business Continuity Institute
BCM	Business Continuity Management
BCP	Business Continuity Planning
BIA	Business Impact Analysis
BMA	Business Model Analysis
DRP	Disaster Recovery Planning
ERM	Enterprise Risk Management
IRP	Incident Response Planning
MTO	Maximum Tolerable Outage
RTO	Recovery Time Objective
SCM	Supply Chain Management
SCRM	Supply Chain Risk Management

Table of Contents

1. Introduction

In the beginning of this chapter the background and motivation to the thesis is explained. Then the purpose and objectives are set and the potential contributions of the study for different target groups discussed. Finally the conditions and delimitations of the thesis are stated and a disposition of the thesis is visualized.

This project is the master thesis of the education in Master of Science in Risk Management and Safety Engineering at the Department of Fire Safety Engineering and Systems Safety at Lund University. The project will be completed during the autumn of 2008 within 20 weeks of full time studies. The project assigner is DeLaval International AB. The project will be started and finished in Lund while the main part will be performed at DeLaval´s central warehouse in Glinde outside of Hamburg.

1.1 Background

Today's society is based on globalization, specialization and mass-production, to mention a few relevant trends. Hardly any company or production unit manufactures the whole product today, unless it is a much uncomplicated one (Paulsson, 2007). We now live in a world where the largest shoemaker does not actually make shoes, but only designs and sells them. A world where the largest direct seller of personal computers does not so much manufacture its products as they assembles them from components sourced elsewhere (Bosman, 2005). The society is instead based on highly integrated supply chain flows where the single company is just one link in the chain and each link adds a part of the total value of the final product (Paulsson, 2007). The development of modern enterprises goes towards even more complex supply chains with many links and worldwide transportation. Outsourcing, lean manufacturing and just in time delivery is modern business strategies to help companies to be more efficient and focus on core competencies. But these strategies also affect the supply chain and create new risks which can make companies vulnerable (Sheffi, 2005; Brannen & Cummings, 2005).

A number of severe company events caused by supply chain disruptions have occurred during the recent years, which illustrates that a single disruption in the supply chain can easily have domino effects and spread to other parts of the chain (Bartholomew, 2006; Sheffi, 2005). Therefore it is important for the single company to monitor the entire supply chain from natural resources to end customer.

If a disruption occurs the effect can be devastating, with lost market shares as a consequence, it can reduce the company's revenue, inflate the costs, send the company over budget and threaten production and distribution. Disruptions can also damage the credibility with investors and other stakeholders and thereby driving up the cost of capital. Insurance may cover the loss of property,

equipment and some of the business interruption, but it will not reclaim customers who take their business elsewhere while the business is down (Bosman, 2005). This is especially important if the disruption reaches the end market where the customer can choose a similar product from a competitor. If it is a unique product it is more likely that the customer will be indulgent with delays. Without any plans and preparations the consequences of a disruption can grow larger than necessary. One part to preserve the continuity in a business is a well organized and prepared crisis management team within the enterprise (Chong, 2004) and with a Business Continuity Plan (BCP) the ability to respond to a disruption increases and significant losses can be prevented.

One classic example that displays both good and bad crisis preparedness is the Albuquerque event in 2000. A minor fire caused by lightning occurred to one of Ericsson's and Nokia's sub-supplier in Albuquerque, USA. The fire was extinguished in less than ten minutes but since it occurred in a clean room the production equipment was destroyed. The problem was that Ericsson was single sourced on a specific component from Albuquerque and since they did not have a BCP they did not realize that this minor fire could cause them any problems. At this time there was a general lack of capacity for this kind of component in the entire world. Ericsson did not realize the problem in time but their competitor Nokia who was not single sourced on this component and had a BCP realized the negative consequences early. Nokia therefore took action instantly and bought almost all available capacity of this component in the world. (Sheffi, 2005) For Ericsson this was a disaster and they lost several months of production on one specific mobile telephone model, which in the end led to Nokia taking market shares from them (Latour, 2001). The managing director of Ericsson, Kurt Hellström, said that if the fire had not occurred the mobile telephone division would have presented a profit for the first six months in 2000, but now they instead presented a loss of 1.8 billion SEK (Sydsvenska Dagbladet, 2000). Another study shows that Ericsson's financial consequences were equivalent to 4 billion SEK (KBM, 2006).

There are many more examples of companies which have been affected by serious disruptions. Two examples are the tragic events of September 11 and the foot and mouth disease in 2001. To show that the negative impact of these kinds of disruptions can be mitigated with help of a BCP an investigation was made on these two cases in 2002. Among 674 companies, 58 % stated that they had suffered of disruptions caused by September 11 and 44 % that they were affected by the foot and mouth disease. After these situations, 20 % of the companies stated that they had minimized the effects of the disruptions thanks to their BCPs (Woodman, 2002).

These cases further show the importance of crisis preparedness as a part of the enterprise Business Continuity Management program. The majority of the worst cases involve disruptions in the supply chain which is seen as the primary threat to a company's revenue driver (Brannen & Cummings, 2005). A study by Hendricks and Singhal of nearly 800 instances of supply chain disruptions showed that the companies on average had a drop of 107 % in operating income, 7 %

lower sales growth and 11 % growth in cost in the year of the disruption, and continued to operate for at least two years at a lower performance level (Hendricks & Singhal, 2005).

In a study made by the Chartered Management Institute, 73 % of 1257 managers reported that Business Continuity Management is important to their organisation, and 94 % of those who had invoked their plans agreed that they had reduced disruption. Despite the perceived importance and range of disruptions over half of the 1257 managers surveyed in 2007 reported they worked in organizations where there was no specific BCP in place (Woodman, 2007).

One modern trend for enterprises to be more efficient is by reducing their stocks to minimal levels. This development is not without risks. By holding low stock levels through the supply chain the risk for disruption somewhere in the chain increases. A company's central warehouse is a major part of the supply chain and therefore risks regarding the central warehouse must be handled in a proper way. A large part of a company's flow of goods passes the central warehouse. If a disaster occurs there, the consequences can be devastating for the entire company.

We have chosen to perform a case study at DeLaval International AB and their central warehouse located in Glinde, outside of Hamburg in Germany. DeLaval is a global company which operates in the agricultural sector and is specialized within products for milk production. The management of DeLaval has realized the risks with centralized warehousing as logistic setup. Therefore DeLaval has given us the assignment to investigate how the risk can be reduced at their central warehouse in Glinde.

1.2 Purpose

The purpose of the project is to contribute to the knowledge on how disruption risks in a supply chain with just one central warehouse can be effectively managed.

1.3 Objectives

The objectives of this project are:

- To penetrate how supply chain disruption risks of a totally destroyed central warehouse in a supply chain with just one central warehouse can be identified, evaluated and structured.
- For such a situation develop a guide that helps to generate new alternatives, for the delivery of products and services from supplier to end customer, and mitigation of the negative impact on such disruption risks.

1.4 Target Groups

- Academia: The theories and methods applied in the project will be of academic value within the areas of Business continuity planning and Supply chain risk management.
- Business world: Corporate management teams, especially in organizations which have just one central warehouse in their supply chain, can gain increased knowledge on how to identify structure and evaluate supply chain disruption risks and how to find alternative options for their delivery of product and services.

1.5 Conditions and Delimitations

- The condition is that one central warehouse is used as logistic setup. The option to spread the risk by adding another warehouse in Europe will not be considered.
- The scenario is that the central warehouse is totally destroyed.
- The time horizon before the site is back to a capacity of 100 % is 18 month. The time horizon was decided to be 18 month since this is standard as indemnity period. An indemnity period is a limit during a business interruption relating to the maximum period over which the insurer will pay for loss of gross profit.
- Only business profit impacts will be considered.
- The scope of the guide will cover warehouse and office functions. Back-up plans for IT-systems will not be considered.
- When the supply chain is studied the focal unit will be the entire company and not only the central warehouse (CW), see Figure 1.1. The Business Impact Analysis will therefore regard the whole company.

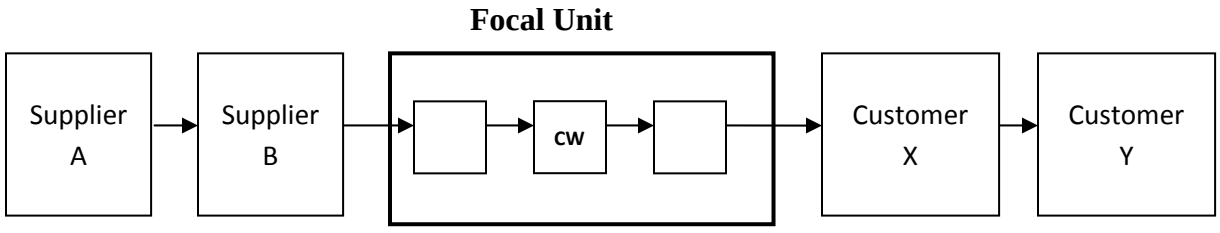

Figure 1.1: Focal unit.

1.6 Disposition

Chapter 1: The introduction with background, purpose, objectives, conditions and delimitations are presented in this chapter.

Chapter 2: The methods used in the thesis and how they correspond to achieving the objectives and the demands from methodological and scientific theories are discussed.

Chapter 3: The underlying theory is presented. It is based on already existing knowledge and gives an understanding of the central theories which underlie the result of the thesis.

Chapter 4: The chapter begins with a general presentation of DeLaval International AB. It contains a summary of how the case study at DeLaval Services GmbH was conducted and of some documented mini cases.

Chapter 5: The development of the guide. The structure of the guide is presented here. The preliminary guide is also tested and changes are implemented.

Chapter 6: A discussion on how the objectives of the thesis are met and how the purpose is fulfilled. The applicability of the guide and possible areas for future research are discussed.

References

In figure 1.2 the chapter overview is illustrated.

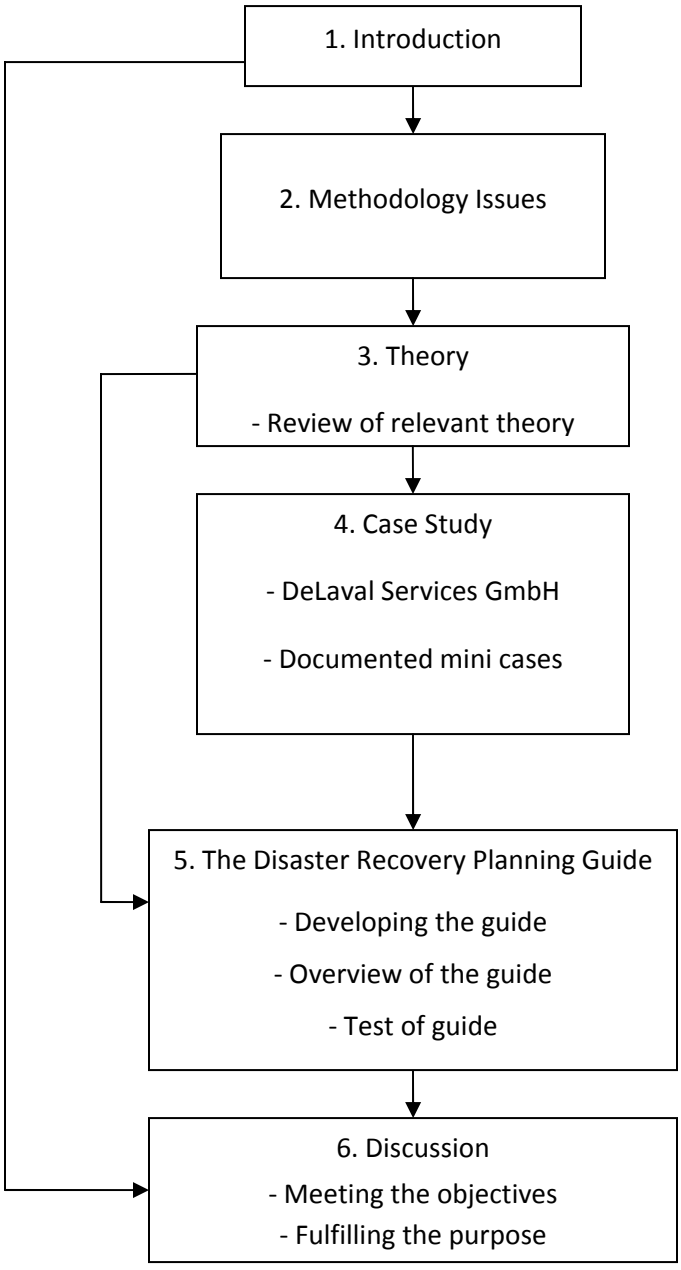

Figure 1.2: Chapter overview

2. Methodology Issues

In this chapter the methods used in the thesis and how they correspond to achieving the objectives and the demands from methodological and scientific theories are discussed.

In a scientific report it is significant to describe the procedures in detail. There is a difference between methodology and method. Methodology means which principles of logical and philosophical art methods are based on (Paulsson, 1999). The method describes the practical scientific work procedure and could comprise of tools to collect and analyze data (Saunders et al., 2003). The purpose with the method is to make it possible for other persons to replicate and evaluate the work procedure (Backman, 1998).

2.1 The Research Process

There are several perspectives to consider in the research process. Saunders et al. (2003) visualizes this with an onion with different layers, see Figure 2.1. First of all the scientific process can have different philosophies, where the three dominated are positivism, interpretivism and realism.

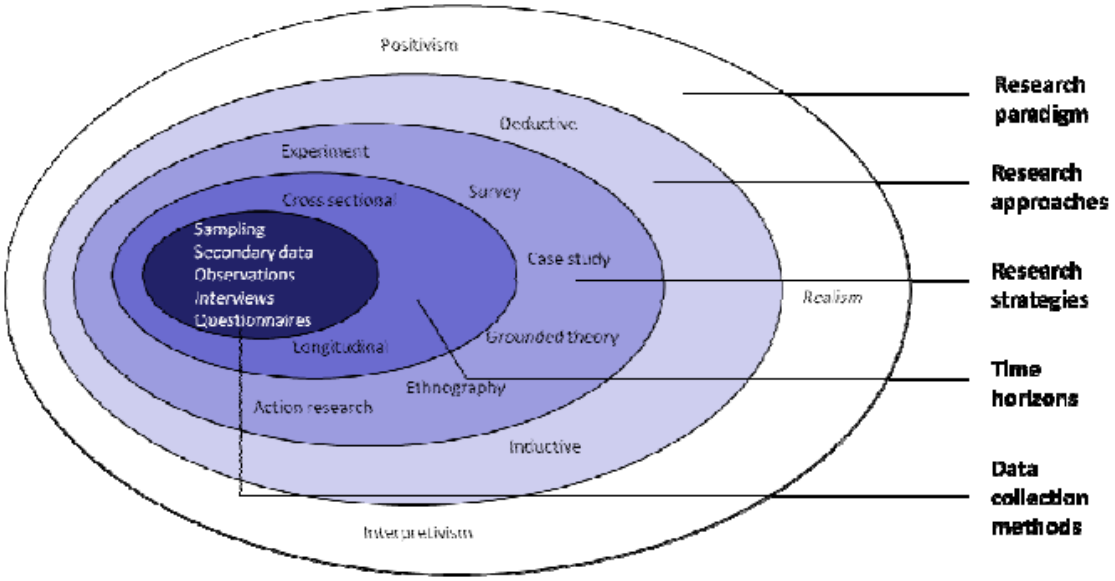

Figure 2.1: The research process onion to Saunders et al. (2003)

2.2 Research Approaches

There are two approaches to the reality; the traditional perspective and the qualitative perspective. In the traditional perspective the individual is seen as a spectator who contemplates the world around from outside, which is seen as objective. In the qualitative perspective the individual is a part of the world around, which implies the individual looks at the world around in a subjective way. (Backman, 1998)

The traditional approach is mainly deductive, while the qualitative approach is mainly inductive (Backman, 1998). The deductive approach starts with a theory which later is tested. The inductive approach collects information and sets up theories based on the collected information (Saunders et al., 2003).

Both the deductive and the inductive approach are used in the thesis. Information is collected through studies of literature and at the case study at DeLaval in Glinde to develop the guide and this part has a clear inductive approach. The deductive element comprises the test of the guide on two external risk management consultants and one manager at DeLaval's head quarters in Tumba.

2.3 Research Strategies

The research strategy tells how to fulfill the purpose and answer the scientific question of the research. (Saunders et al., 2003). There are several research methods to choose from.

Case study is one of the most used methods within the qualitative perspective. In a case study a small part of a population is studied and conclusion from the studied part is applied to the entire population. Advantages of case study are that it requires relative little time and that the studied part tells something of the population as whole. The weakness with a case study is that it is rare that the studied part represents the entire population and therefore the conclusions can be difficult to generalize (Ejvegård, 2003).

Case study is the main method in the thesis combined with studies of literature. The gained knowledge in the field of Business Continuity Management (BCM) and Disaster Recovery Planning (DRP) is applied on a real object; DeLaval in Glinde, which can be seen as the target object within the entire population which all global companies constitute. Case study has been chosen as method because the resources and time is limited to investigate more than one company. DeLaval is a global company which fulfills the requirements as target object. Based on these two inputs a general guide how to develop a DRP is produced. The general guide was tested on three experts, two external risk management consultants and one manager at DeLaval's

head quarter. The received feedback was taken into consideration to make some adjustments and form the final guide. Based on the final guide a DRP was developed for DeLaval's site in Glinde. The working procedure is visualized in Figure 2.2 below.

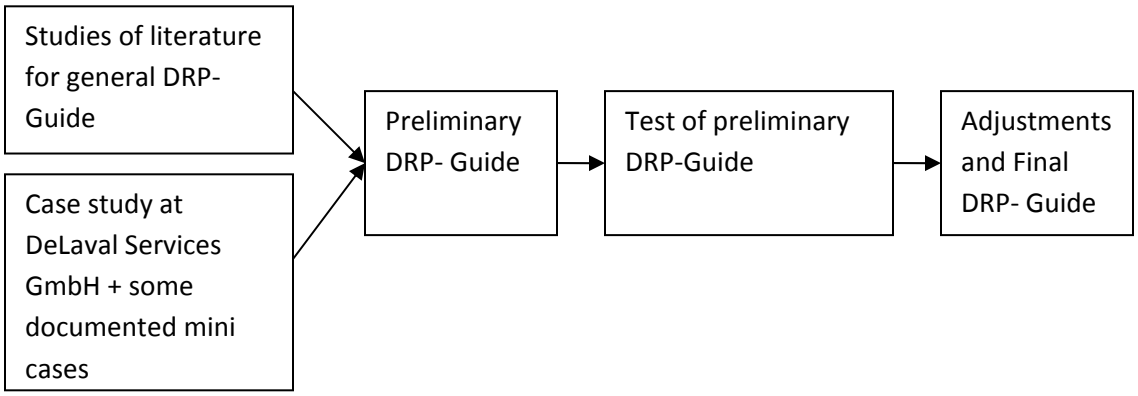

Figure 2.2: The working procedure of the thesis.

2.4 Time Horizon

The research could either have a cross-sectional approach or a longitudinal approach. In a cross-sectional approach a snapshot is taken at a certain time, while the longitudinal approach follows the studied object over time (Saunders et al., 2003).

In the thesis the research strategies are mainly cross-sectional. The DRP-Guide will be used in a longitudinal way, since it is a process requiring time to develop a DRP.

2.5 Data Collection Methods

There are two main categories of techniques to gather information to a report; quantitative and qualitative. The quantitative technique uses measurements and quantifications with mathematics and statistics, for example experiments and questionnaires (Backman, 1998). The qualitative technique does not use any numbers. Instead it uses written or spoken formulations to express conditions (Backman, 1998). A common used qualitative technique is interviewing. In the thesis qualitative methodology is mainly used, but the procedure to collect material for the Business Impact Analysis can be regarded as principally quantitative. The collected information could either constitute primary or secondary data.

2.5.1 Primary Data

Primary data shall constitute new information and shall be collected specific for a project. In the thesis the interviews and meetings that have been carried out with DeLaval Management and employees in Glinde in purpose to get a comprehensive understanding of the DeLaval's business and organization, is an example of primary data.

2.5.2 Secondary Data

Secondary data are collected from already publicized information. It is important to be aware of that information can be angled in some direction (Ejvegård, 2003). Secondary data is the foundation for the underlying theory which is based on studies of literature in the thesis.

2.6 Reliability and Validity

Reliability and validity are two concepts used to ensure that the research results have scientific value. It is significant that parameters, measurement instruments and investigation methods are reliable and valid. If these aspects are not fulfilled, the research result will have low scientific value. (Ejvegård, 2003)

The reliability states the trustworthiness of a measuring instrument and the unit of measurement. If the reliability is high the same experiment shall give the same result at repeated attempts (Paulsson, 1999). The validity states to which extent you really measure what is intended to be measured (Ejvegård, 2003).

To ensure that the guide is valid the procedure to develop the guide also has to be proven to be valid. All assumptions made during the development of the guide are tested on DeLaval Management and employees during the process. To validate the final guide it was tested on three experts, two external risk management consultants and one manager at DeLaval's head quarter.

2.7 Objectivity and Sources

A scientific report shall be objective and balanced. It is vital for the author to be objective and to report everybody's opinion and to be clear about whose opinion is referred to. Objectivity implies the published material shall be correct and to accomplish this it is important that the author audits his sources and controls the gathered information. A balanced report is characterized by the fact that it gives appropriate space to the different parts. Important analyzes, assessments and conclusions shall be prioritized in the report while less important details shall have smaller space (Ejvegård, 2003). Through the studies of literature several sources will be used to view a topic from different angles and thereby try to achieve objectivity.

Relevant literature is studied to create a deeper comprehension about the subject and constitutes the foundation for the underlying theory. The sources are reviewed to a reasonable extension. The material is primarily collected from books and scientific articles. Articles published in magazines will be judged by the trustworthiness of the actual author and magazine. Material has been searched in Lund University's databases Elin and Lovisa. The seek words comprise mainly of the words especially defined in the chapter Definitions or a combination of these words. World leading risk management firms' internal framework in the area of Business Continuity Management constitutes an important input. Webpages of established institutes and authorities has also been used as sources.

3. Theory

In this chapter the underlying theory is presented. It is based on already existing knowledge and gives an understanding of the central theories which underlie the result of the thesis.

3.1 Risk

There are many definitions of risk. The one used here is by Kaplan and Garrick (1981) who define risk as: *a triplet that answers the following three questions. What can happen? How likely is it to happen? If it does happen, what are the consequences?*

The answers to these questions can be expressed with the triplet of scenario (S), likelihood (L) and consequence (X). The risk is the sum of all scenarios, the likelihood that they occur and the consequence they cause. This definition is especially useful when performing risk analysis.

The International Organization for Standardizations' (ISO/IEC) defines risk as*: the combination of the probability of an event (a set of circumstances) and its consequences* (ISO/IEC, 2002). An event can have several consequences, both of positive and negative nature (ISO/IEC, 2002).

Hamilton (1996) has another approach to risk applied to the corporate world*: "Risk is the danger of a random event negatively affecting the ability to achieve an objective."* This definition is similar to COSO's view of Enterprise Risk Management, which will be studied in chapter 3.4. COSO (2003) defines risk as: *the possibility that an event will occur and adversely affect the achievement of objectives.*

3.2 Risk Management

The risk management process contains three steps; risk analysis, risk evaluation and risk reduction/control, see Figure 3.1. The risk analysis starts with determining the scope of the analysis. Then an identification of all potential hazards take place. There are many risk analysis methods available that can be used in the identification phase and which to choose depends on the circumstances and the resources available. The categories of methods will be studied more in detail in chapter 3.3. An estimation of the probability and impact for each risk then takes place. The probability represents the possibility that a given event will occur, while impact represents its effect if it occurs. (IEC 1995)

In the second step of the process, the risk evaluation, a decision if the risk is acceptable or not shall be taken. The risks which are not acceptable become target for an option analysis, where risk-reducing options are investigated and compared. The risk analysis together with the risk evaluation represents the risk assessment. (IEC 1995)

The third and last step is risk reduction/control. Here the most suitable risk-reducing alternative in the previous step is chosen and implemented. Monitoring the risks to be within the company's risk appetite is a work that never ends. Since new risks come up all the time new risk analysis has to be carried out regularly. To manage a company's risks is therefore a continuous process. (IEC 1995)

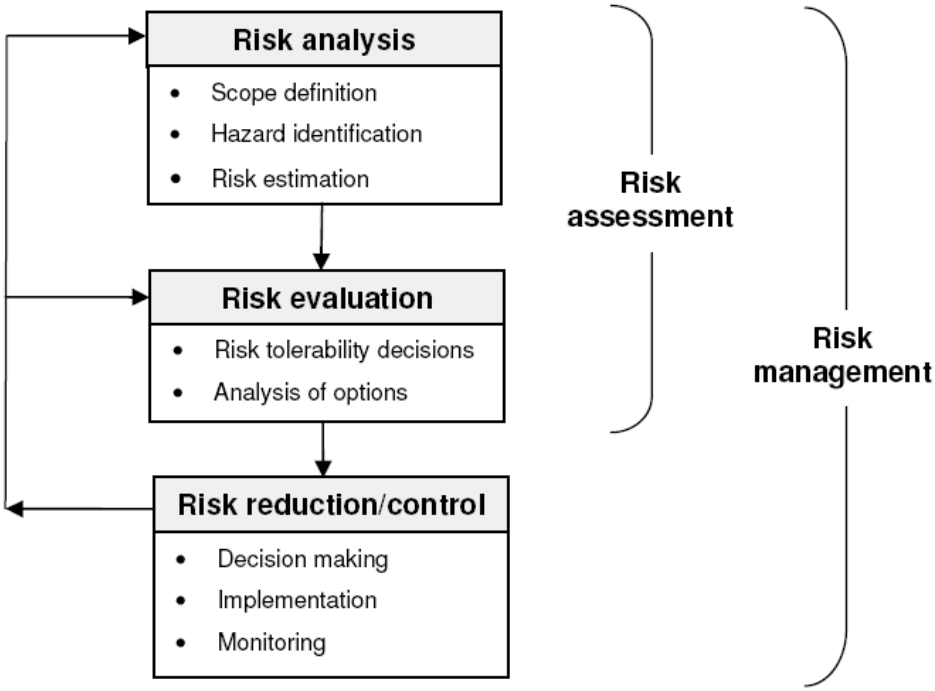

Figure 3.1: Risk Management process according to International Electrotechnical Commission (IEC 1995)

3.3 Risk Analysis Methods

There is a wide spectrum of different risk analysis methods, see Figure 3.2. Which method to use depends on the target of the analysis. As there are many kind of risks it is hard to express the result in a single way. A classification of risk analysis methods are usually made with respect to the level of qualitative and quantitative elements.

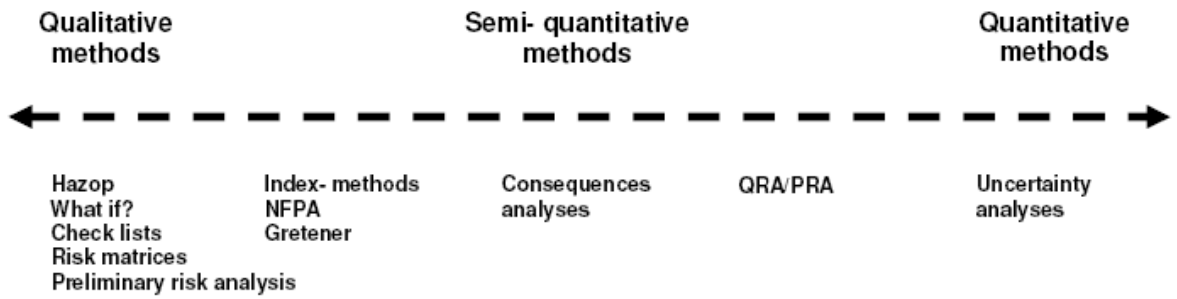

Figure 3.2: The spectrum of the different risk analyses methods with respect to the level of qualitative and quantitative elements (Olsson 1999; Nilsson 2003).

Qualitative Methods

Qualitative methods are most useful in the risk identification phase, in the first part of the risk analysis. The purpose is mainly to describe events at different conditions. An ordinal estimation of probability and consequence can be made to compare risks with each other. Common methods are HazOp, What if ?, checklists and preliminary hazard analyses. (Nilsson 2003)

Semi- quantitative Methods

The semi- quantitative methods are more detailed in its construction and consist partly of numerical measures of probability and consequence. The numerical measures are not fixed but facilitate to choose between different alternatives associated with risk. A risk matrix with numerical elements is an example of a semi- quantitative method. (Nilsson 2003)

Quantitative Methods

The quantitative methods are completely numerical. The uncertainties in calculation models and input are taken into account and these uncertainties are reproduced to the end result. The calculation can be either deterministic or probabilistic. QRA, *quantitative risk analysis* is an example of a quantitative method used commonly in the process industry. PRA, *probabilistic risk analysis* is more detailed than the QRA and the method is often used in the nuclear industry. (Nilsson 2003)

3.4 Enterprise Risk Management

The target for any business is to deliver products and service to the market in order to generate value for stakeholders. The effective delivery of these products and service is enabled by a number of processes, which exist both inside and outside the organization. In all businesses there

are certain products and service regarded as critical to continued success, because they generate a lot of value. This means that the processes enabling the delivery of these critical products and service will themselves be considered critical to the business (FM Global, 2007). If such a critical process should fail for any reason, the consequence can be an interruption in the delivery of critical products and service, which will reduce the value generated for stakeholders. As a response a business needs to protect their critical processes to ensure they are able to withstand disruption and to continue the delivery of products and services. To achieve this objective the business has to be sufficiently resilient (FM Global, 2007). Enterprise Risk Management (ERM) constitutes not only a tool for companies to create sustainable value, it also facilitates for management to communicate the value created to stakeholders (COSO, 2003).

When checking risk on enterprise level Kaplan and Garrick's definition is hard to apply. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) (2003) definition of ERM can be more suitable in several cases:

Enterprise Risk Management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risks to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives (COSO, 2003).

COSO is an independent private sector initiative with the purpose to improve the quality of financial reporting and its recommendations has become a guideline for the evaluation of internal control systems (Henke, 2008). The definition is broad and adapted to suit all companies regardless of size or structure (Eichler and Bungartz, 2004). In the thesis the COSO definition of ERM will be applied and the focus will be on such risks that threaten the achievement of the enterprises core objectives.

COSO has visualized the relationships between an enterprise's objectives and the components of risk management in form of a cube see Figure 3.3.

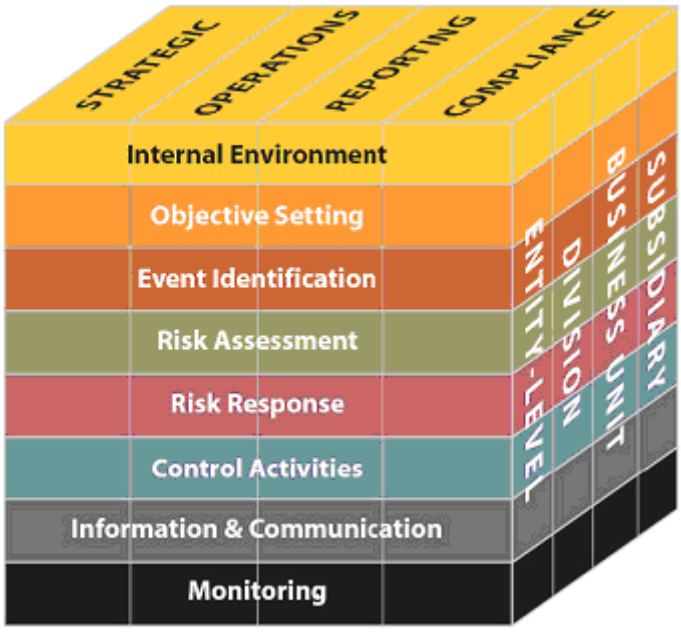

Figure 3.3: COSO's depicture of the relationships between an enterprise's objectives and the components of risk management (COSO, 2003).

The cubes three dimensions contain:

- The four objectives categories – strategy, operations, reporting and compliance – are represented by the vertical columns.
- The eight components are represented by horizontal rows.
- The entity and its organizational units are depicted by the third dimension of the matrix.

Internal Environment

The entity's internal environment is the foundation for all other components of ERM. The board of directors constitutes a key part of the internal environment because their attitude significantly influences other internal environment elements. As part of the internal environment, management establishes a risk management philosophy, establishes the entity's risk appetite, forms a risk culture and integrates ERM with related initiatives. (COSO, 2003)

The ERM philosophy is the entity's beliefs about risk and how it chooses to manage risk. The philosophy shall be communicated by the management to all personnel and understood by them. This will improve the way the employees recognize and manage risk. It is of major importance that the management not only communicates the philosophy by words, but with everyday actions as well. (COSO, 2003)

The risk appetite, established by management constitutes an important part of setting the company's strategy. It is important that the management chooses a strategy which is consistent within its risk appetite. Risk culture is the set of shared attitudes, values and practices characterizing how an entity considers risk in its day to day activities. Establishing an ERM philosophy and determine the company's risk appetite help creating a good risk culture. (COSO, 2003)

Objective Setting

Management has to set strategy and related objectives before the event identification can start, since the event identification focuses on the achievement of the entity's core objectives.

According to COSO (2003), entity objectives can be viewed in the context of four categories:

- Strategic – relating to high-level goals, aligned with and supporting the entity's mission/vision.
- Operations – relating to effectiveness and efficiency of the entity's operations, including performance and profitability goals. They vary based on management's choices about structure and performance.
- Reporting – relating to the effectiveness of the entity's reporting. They include internal and external reporting and may involve financial or non-financial information.
- Compliance – relating to the entity's compliance with applicable laws and regulations.

Event Identification

This step focuses on identifying events that can affect the achievement of the entity's core objectives. Management has to consider both external and internal factors that affect event occurrence. Which techniques to use to identify events can vary among different companies. It is wise to use a technique focusing on both trends in the past as well as predicting future exposures. Events that have a negative impact represent risks, compare to the definition of risk in chapter 3.1 and these events require further assessment and response. There are also events that have a positive impact and these events represent opportunities and should be considered in the next steps. (COSO, 2003)

Risk Assessment

In the risk assessment, management estimates the likelihood and impact of the identified events and discusses options to deal with risks that are not tolerable. COSO's view of the risk

assessment is quite similar to IEC's definitions of the risk management process presented in chapter 3.2. A difference is that COSO (2003) takes a slightly more holistic view of the risks within a company. COSO stresses that events can correlate and create combinations of events with much deeper impact than the events have separately. COSO provides the risks that are being assessed into the context of the company's strategy and objectives.

Risk Response

For those risks considered not tolerable, management shall select an appropriate response to bring the risk within the entity's risk tolerance. There are four main categories to respond to a risk; avoidance, reduction, sharing and acceptance. Avoidance implies actions taken to exit the activities which create the risk. A risk reduction can be conducted either by reducing the likelihood or the impact of the risk or reducing both these parameters.

The purpose with sharing the risk is to transfer it to another company, usually an insurance company. This is common with risks characterized with low likelihood and high impact. Acceptance means the risk is being ignored and no action taken to affect the likelihood or impact. Some level of residual risk will always exist because the future is uncertain and it is not cost effective to manage all risks. The important thing is that the entity's risks are within its risk appetite. (COSO, 2003)

Control Activities

Control activities are the policies and procedures that help ensure risk responses are properly executed. These activities take place all over the organization. The two elements that usually are involved in control activities are policy establishing and procedures to affect the policy. Information Systems constitute a vital part of every organization. Therefore there have to be control activities regarding these systems. Usually difference is made between general controls and application controls. (COSO, 2003)

Information and Communication

Large volumes of information, from both internal and external sources flow through an organization. An important task for management is to refine the information and make it useful for the work with ERM. Without relevant information it is hard to identify, assess and respond to risks in a proper way. Information constitutes the foundation for the communication within an organization and with external parties. Therefore it is important to have good communication channels throughout the enterprise. This is a condition for successful ERM. One of the most important communication channels is between top management and the board of directors. (COSO, 2003)

Monitoring

To monitor ERM is a process that assesses both the presence and functioning of its components and the quality of their performance over time. Monitoring can be done either through ongoing activities or separate evaluations. Problems will probably be identified faster by ongoing monitoring routines compared to separate evaluations, since the latter take place after the fact. A suitable level of documentation of the monitoring process usually makes it more effective. (COSO, 2003)

It is important when ERM deficiencies are discovered that they are being reported in the right way through the right communication channels. If deficiencies not are reported it will complicate improving ERM. There should also be alternative communication channels for reporting sensitive information. (COSO, 2003)

3.5 Supply Chain

There exist many definitions of the term supply chain. Most of them are similar and have the same meaning. Traditionally it has been defined as: *an one-way, integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers*. Under this definition, the supply chain includes only those activities associated with manufacturing, from raw material purchasing to final product delivery. (Beamon & Benita, 1999)

A wider definition was made by Beamon (1998), who defines the supply chain as: *a set of relationships among suppliers, manufactures, distributors, and retailers which facilitates the transformation of raw material into final product*. This definition is wider since it includes not only manufactures but also suppliers, distributors and retailers. It is similar to the traditional one in the way that it explicitly mentions that the supply chain goes from raw material to final product.

Another definition of the supply chain is:

The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of product and services in the hands of the ultimate consumer (Christopher, 1998).

This definition emphasis that the supply chain, through a network of organizations, produces a value not only consisting of products, but also of service to the consumers. It does not explicitly mention that the supply chain goes from raw material to final product. However it describes the chain as a network of organizations involved through upstream and downstream linkages. This

approach makes it easier for a single company to understand its position in the chain and therefore this definition will be chosen in this thesis.

It is important to consider that the supply chain consists of a network of individual companies. Therefore the supply chain does not exist from a legal point of view and cannot take actions itself. The individual companies can of course take joint actions and decisions, which mean although the supply chain does not legally exist; the actions can be taken from a supply chain perspective. (Paulsson, 2007)

Supply chains are vulnerable and a disruption can strongly influence the mission of the chain. A supply chain disruption can be defined as: *an interruption in the continuity of the normal supply chain flow with a negative result impact* (Paulsson, 2007).

The mission of the supply chain is to efficiently and effectively transform and distribute resources taken from nature into final products serving end customers needs (Paulsson, 2007). Looking at the reality and most commercial supply chains, the objective of every supply chain is to maximize the overall value generated, where value will be strongly correlated with profitability (Chopra & Meindl, 2001).

In order for the individual company to become more competitive, changes have to be done and actions have to be taken within areas like product development, marketing, financing, distribution etc. Today competition tends to be between different supply chains rather than between different individual companies, which has led to increased focus on the competitiveness of the whole supply chain (Christopher, 1998).

3.5.1 Supply Chain Trends

The actions taken to increase the efficiency and effectiveness in the supply chain can be clustered into trends. One problem is that some of those trends not only increase supply chain competitiveness, they affect supply chain vulnerability as well (Paulsson, 2007). The links in the supply chain are deeply integrated with each other and therefore a disruption somewhere in the chain easily can spread to other parts of the chain. The development the last years is that supply chains become more vulnerable and therefore many companies risk exposure have increased. The trends are affecting the supply chain flow and changing its structure. The structural change will in turn change the supply chain vulnerability (Paulsson, 2007). Below follows a review of some trends affecting the supply chain vulnerability.

Centralized Warehousing

One modern trend for enterprises to be more efficient is going towards centralized warehousing. A study made by the European Logistics Consultant showed that 90% of the analyzed enterprises

were on the way to reorganize their distribution structure towards one centralized warehouse (Mattsson, 2002).

Centralized warehouse pooling is the consolidation of multiple warehouse locations into a single one. Warehouse locations may be associated with different geographical sites, different products, or different customers. The need to assess the benefits of warehouse pooling arises in a variety of contexts. For example, manufacturing firms need to determine whether to have few large centralized distribution warehouses or several smaller local ones. In doing so, they must trade off the inventory economies realized from a centralized warehouse against the value of proximity to customers that comes from having several local ones. (Eppen 1979)

Centralized vs. Decentralized Warehousing

Abrahamsson (1992) has identified some positive and negative results of the centralization process. Some advantages with centralization is that the variable costs are decreasing since there will be lower tied up capital in the organization. The fixed cost will be decreased due to the cost for labor and stock will be reduced. Other advantages that Abrahamsson (1992) identified were that integration in the form of centralized information flow increases and the lead times to the market gets shorter because the administrative lead times get clearly decreased. This, in turn, leads to increased delivery accuracy.

The disadvantage with a centralized structure is that more orders will be handled through the central storing unit, and the transportation from the central unit will be more frequent. The centralization process thereby becomes more complicated than the decentralized, it requires a well integrated information system, and that kind of information system is often a very costly investment which small and middle size companies cannot afford. (Abrahamsson, 1992)

One of the advantages with decentralized distribution is the nearness to end customer, which is crucial for products requiring secure and quick delivery. Another aspect is the transportation cost; if the transportation cost is high related to the value of the product then a decentralized warehouse is the optimal solution. (Mattsson, 2002)

In the paper *centralization vs. decentralization* Schmitt et al. (2008) investigates the risk pooling effect, the risk diversification effect and the supply uncertainty in a system with one warehouse and multiple retailers and with both supply and demand uncertainty.

The risk pooling effect occurs when inventory is held at a central location, which allows the demand variance at each retailer to be combined, resulting in a lower expected cost (Eppen, 1979). The risk diversification effect occurs when inventory is held at a decentralized set of locations, which allows the impact of each disruption to be reduced, resulting in a lower cost variance (Snyder and Shen, 2006).

The investigation shows that the risk pooling effect reduces the expected cost but not the cost variance in the centralized system. Furthermore it proves that the risk diversification effect reduces the variance of cost but not the expected cost. The difference in cost variances between the centralized and decentralized systems is greater for longer disruptions, but the difference in expected cost is greater for shorter disruptions. The intuition behind this effect is that by distributing inventory at multiple sites, the impact of any disruption is smaller, even though each site is still affected by the same number of disruptions. A central facility leaves the enterprise more vulnerable to a physical attack (Sheffi 2002). The firm benefits from not putting all its eggs in one basket; although the same number of eggs may be destroyed, they are not all destroyed at once (Schmitt et al. 2008). If a disruption occurs there are more alternatives to handle a disruption with decentralized warehousing since that system includes more possibly paths to reorganize the flows (Paulsson, 2007).

There are some advantages with centralized warehousing from a risk perspective. It gets easier to monitor the risks and to find superior solutions for risk handling. When flows are concentrated, they can be protected more efficiently when it comes to transportation, warehousing and production (Paulsson, 2007).

The advantages and the disadvantages regarding centralized- and decentralized warehousing is by the authors summarized in Table 3.1 below.

Table 3.1: Centralized vs. Decentralized Warehousing

	Centralized	Decentralized
Variable costs	+	-
Fixed costs	+	-
Cost variance	-	+
Integration of information	+	-
Lead times	+	-
Delivery accuracy	+	-
Complexity	-	+
Nearness to the end customer	-	+
Transportation costs	-	+
Risk (Vulnerability)	-	+
Monitoring Risk	+	-
Risk Handling Options	-	+

It is difficult to draw direct conclusion from the table. From a financial view it looks like the centralized option is to prefer but the complexity of such system and the risk it brings to put all the eggs in one basket shall not be underestimated. The investigation by Schmitt et al. (2008) also shows numerically that, when disruptions and demand uncertainty are both present, both the risk pooling and the risk diversification effects occurs to a certain extent. However in most cases

the risk diversification effect strongly dominates the risk pooling effect. The risk diversification effect is as most pronounced when disruptions are longer and more costly. Therefore a decentralized system is optimal for risk-averse firms when disruptions and demand uncertainty are both present. Exceptions are when the service level is very low, the firm is very risk neutral, and/or the system is very reliable (Schmitt et al. 2008).

Single- and Multiple Sourcing

Single sourcing is becoming a more and more usual supplier strategy in the market today. However traditionally, companies used to have several suppliers for every raw material, component or service to spread the risks. Supplier strategies involves how the flow of material for the production is handled (Jonsson & Mattsson, 2005).

Single sourcing can be defined as: *fulfillment of all of an organization's needs for a particular purchased item from one vendor by choice* (Treleven, 1988). It can also be defined as: *the purchasing of all of its needs for a particular purchased item from a single production facility* (Treleven, 1988). Jonsson and Mattsson (2005) define single sourcing as: *one company is the only supplier of one article to the purchaser.*

The second definition is more specific than the other ones, since it recognizes that the supplying organization may have more than one facility capable of producing the given item, but the purchaser wants all supply to come from the single, specified location. The first and third definitions are similar but differences in one way. The first definition emphasis that single sourcing is having one source by choice and not because no other feasible sources exist, which in some literature is defined as sole sourcing. For the thesis the second definition is a bit too specific and to not confuse the concept with other literature the first definition will be used here.

Multiple sourcing refers to an organization purchasing an identical part from two or more suppliers. If only two vendors are used, this is a special case of multiple sourcing called dual sourcing. (Treleven, 1988)

Advantages and disadvantages, Single- and multiple sourcing

At single sourcing, the relations between the supplier and customer improve and the contacts are more frequent. The dependence between them increases which makes the two parties more likely to nurture the relationship. This results in benefits such as improved product quality, less supplier variations, higher efficiency and increased competitiveness through joint product development. Another advantage of single sourcing is that the cost of maintaining the supplier relationship decreases. This is because with a smaller number of suppliers the work effort required to manage the relationship with them decreases.

The benefits with multiple sourcing are that there is always another supplier if one falls away, which leads to reduction in the disruption risks. Another benefit is that the price can be pressed as the competition between the suppliers increases (Jonsson & Mattsson, 2005).

The advantages and disadvantages between single- and multiple sourcing are summarized in Table 3.2. It is easy to be misled by the table and make the conclusion that single sourcing is preferred before multiple sourcing, since it has the largest number of advantages. However which strategy to choose depends on how the market for the specific article is, and what significance the article has is in the production (Jonsson & Mattsson, 2005).

An example of this is according to Jonsson & Mattsson (2005) that multiple sourcing usually is used if the article is a standard article, which is easily assessable on the market. This is because the benefits of multiple sourcing are greater than those with single sourcing since the price can be pressed at the same time as the disruption risks decreases as the suppliers are easy to replace.

Another way to be misled by the table is that the disruption risks are underestimated. Single sourcing maybe advantageous from a cost and quality management perspective, but is dangerous in terms of resilience. For example, if a company goes from multiple sourcing to single sourcing and there is a disruption, e.g. a fire affecting the supplier, the disruption totally cuts off deliveries from the supply side. This means there are no deliveries of the actual component at all. At the same time, there is no other regular supplier from whom the company might obtain extra deliveries, which means risk handling is becoming more difficult than before. The change from multiple to single or dual sourcing has created a new risk situation (Zsidisin et al, 2000). Christopher and Peck (2003) are very skeptical about single sourcing and state the following: whilst it may be desirable to have a lead supplier, wherever possible alternative sources should be available.

Table 3.2: Single vs. Multiple Sourcing (Jonsson & Mattsson, 2005)

	Single Sourcing	**Multiple Sourcing**
Quality of products	+	-
Supplier variations	+	-
Disruption risks	-	+
Supplier relationship	+	-
Joined product development	+	-
Price	-	+
Cost of maintaining supplier relationship	+	-

Outsourcing

Outsourcing means that the company concentrates on its core activities and buys from outside everything that is not part of that (Paulsson, 2007). The driver behind outsourcing is mainly financial advantages, to be more efficient and to liberate capital and resources to the core business. Since outsourcing allows companies to focus on their core business issues, they can have experts outside the company to take care of the details and let them develop the other components. This means a large amount of resources, capital and attention, which might fall on the shoulders of management professionals; can be used for more important, broader issues within the company.

Seen from a risk manager's view, outsourcing has large effects on the risks affecting the company. For example the company looses direct control over the quality, and quality problems can be more difficult to deal with. Product development becomes more difficult to control and steer than before. After a while the company will loose its competence within the outsourced area and becomes a less qualified purchaser. All this increases the risks. Outsourcing also implies that the supply chains are growing longer than before, and that more companies shall coordinate their activities. This makes it more difficult to understand the whole value adding process, since everyone is doing a smaller part of it (Lonsdale, 1999).

Globalization

Globalization means that on the purchasing side raw material, components and services are bought from the geographical part of the world where price and quality for the moment is most favorable (Skjoett-Larsen, 2000). There is also a trend towards globalization on the market side; products are no longer sold only locally but in many different geographical markets. The increased globalization on both the market side and the purchasing side has had the consequence that the suppliers and customers of a company grow geographically farther away from the company than before, and are perhaps also situated in parts of the world with which the company is not so familiar. Furthermore, it often means new suppliers and new groups of customers. All this leads to new possibilities but also increased risks.

3.6 Supply Chain Management

As stated in chapter 3.5 supply chain, the objective of every supply chain is to maximize the overall value generated. To be able to achieve this mission it is necessary with Supply Chain Management (SCM). SCM has been considered as the most popular operation strategy for improving organizational competitiveness in the twenty-first century (Gunasekaran et al, 2008). SCM can be defined as: *the process of planning, implementing and monitoring the everyday operations of a supply chain*.

SCM is an all encompassing process as it undertakes the management of availability of raw materials, the processing into finished goods and the distributions of the same. The aim of all this is to provide the highest level of satisfaction to the customer and thus increase the profit of the company (Stammberger 2007).

SCM can also be defined as: *the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole* (Christopher, 1998).

The first definition is wide and provides good understanding of what SCM is all about. However the latter definition will be used in the thesis since it emphasis the importance of constantly making the supply chain more efficient and thereby become more competitive. The definition also stresses that the key to achieve this is through management of the relationships in the chain.

3.7 Supply Chain Risk Management

The conclusion to be drawn from the supply chain trends are that they have created a changed risk situation for many companies. If the companies are not aware of this and do not take proper actions, the consequences in the event of a disruption might become very serious. This has led to an increased need of risk management in the supply chain area.

There is no general agreed definition of Supply Chain Risk Management (SCRM), but the term can be defined as follow:

The identification and management of risks within the supply chain and risks external to it through a coordinated approach amongst supply chain members to reduce supply chain vulnerability as a whole (Christopher, M. and Peck, H., 2003).

This definition includes risks in- and outside the supply chain and when put in a context it can be described as an intersection between supply chain management and risk management, see Figure 3.4 (Paulsson 2004). This means that SCRM covers combined parts of supply chain management and risk management. At the same time the figure shows that there exist parts in supply chain management that are not covered in risk management and vice versa.

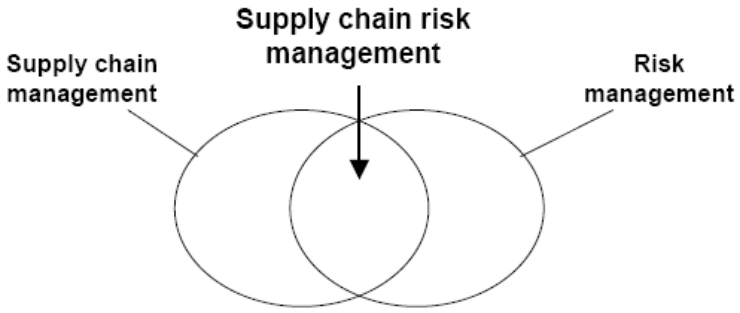

Figure 3.4: Supply chain risk management (Paulsson, 2004).

A similar description was made by Kajüter in 2003, who stated that SCRM may be regarded as a collaborative and structured approach to risk management, included in the planning and control processes of the supply chain, to handle risks which might affect the achievement of the supply chain goals.

According to Paulsson (2004), SCRM is to collaboratively with partners in a supply chain or on your own, apply risk management process tools to deal with risks and uncertainties caused by or impacting on, logistics related activities or resources in the supply chain.

According to the definition and the descriptions of SCRM, the main purpose is to reduce the vulnerability and create a resilient supply chain. Reducing vulnerability means reducing the likelihood of a disruption and increasing resilience (Sheffi & James, 2005). Resilience can be defined as: *the ability of a system to return to its original state or move to a new, more desirable state after being disturbed* (Christopher & Peck, 2004).

There is a close connection between SCRM and ERM. The process model for SCRM includes central ERM objectives and components. The trend is going towards a more ERM-compliant SCRM process. Especially in the field of monitoring, the ERM-framework can contribute to a more comprehensive monitored supply chain. (Henke, 2008)

3.7.1 Categorizing risk in supply chain

To be able to identify risks within the entity it was stated, in chapter 3.4 Enterprise Risk Management, that the entities objectives shall be divided into four categories: strategic, operations, reporting and compliance.

To create a better overview of the supply chain risks, they can be divided into different categories. According to Christopher and Peck (2003) the sources of risk can be categorized into three stages:

- Internal to the focal unit
  - Process
  - Control

- External to the focal unit but internal to the supply chain network
  - Demand
  - Supply

- External to the network
  - Environment

The first category, internal to the focal unit, is divided into two subcategories, process risk and control risk. Process risks are the sequences of value-adding and managerial activities undertaken by the firm. Control risks are the assumptions, rules, systems and procedures that govern how an organization controls the processes. The control risks can be compared with the controlled activities within ERM see chapter 3.4. In the supply chain this refers to order quantities, batch sizes, safety stock policies etc. (Christopher & Peck, 2003)

The second category is divided into two subcategories, demand risks and supply risks. Demand risk relates to the processes, controls, asset and infrastructure dependencies of the organizations downstream from the focal unit. Supply risk is the upstream equivalent of the above. It relates to potential or actual disturbances to the flow of product or information emanating within the network, downstream of the focal unit. The first two categories relates to risk in the supply chain and within control of the focal unit. (Christopher & Peck, 2003)

The third category relates to risk external of the network. This category contains the environmental risks and cannot be controlled neither by the focal unit nor by the network. However the consequences can be mitigated through prevented actions. The consequences of environmental risks can arise as a result of an accident (e.g. a fire), acts of God (e.g. extreme weather or natural disaster) or socio-political actions. (Jüttner et al, 2003)

How the subcategories relate to each other is visualized in Figure 3.5. In the center of the figure the company is presented and there the risks internal to the focal unit exist. On both sides of the company the external risks to the focal unit but internal to the supply chain network exist. Upstream, to the left in the figure the supply risks are visualized and downstream to the right in the figure the demand risks are located. The environmental risks apply to both the company and the whole supply chain.

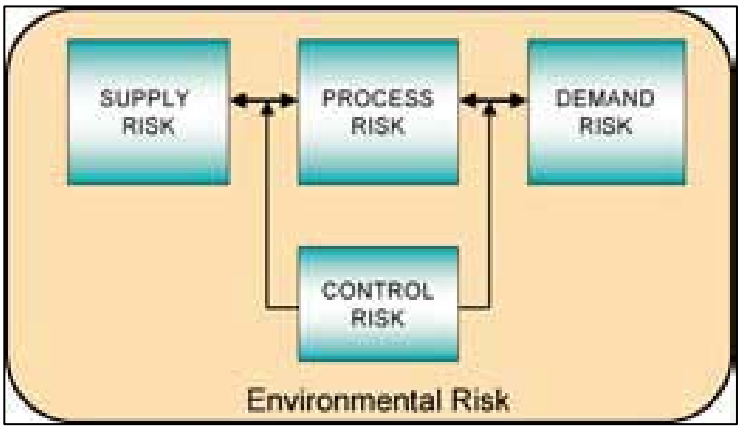

Figure 3.5: The relationship between supply chain risks (Christopher & Peck, 2003)

3.7.2 How to create a resilient supply chain

The definition and descriptions of SCRM gives hints of how to achieve a resilient supply chain. Together with a model from Christopher and Peck (2003) it can be summarized in four steps.

1) Supply Chain (re) Engineering
2) Supply Chain Collaboration
3) Supply Chain Agility
4) Creating a Supply Chain Risk Management Culture

1) Supply Chain (re) Engineering

This step is about designing or redesigning a supply chain. To be able to design a resilient supply chain it is fundamental to understand the chain both upstream and downstream. Key words when designing the chain is flexibility and adaptability. An organizations ability to recover from disruptions can be improved by building redundancy and flexibility into its supply chain (Sheffi & James, 2005). To reach high flexibility it is important to identify and avoid critical path and pinch points in the supply chain where there are limits of capacity or where alternative options may not be available, e.g. where single sourced. Adaptability is also important to take in consideration, since if a distraction occurs to the chain the new state might be different from the original.

2) Supply Chain Collaboration

The supply chain consists of a network of organizations. To be able to identify and manage the risks in the chain it is therefore necessary to cooperate. Collaboration creates a higher level of understanding in the supply chain. The importance of collaboration is mentioned both in the definition and in the descriptions of SCRM above. Christopher and Peck (2004) states that a high level of collaborative working across the supply chain can significantly help mitigate risk. One problem regarding collaboration is that it involves sharing information between different parts of the chain. Sharing information is highly sensitive, but the trend shows greater willingness in doing this (Christopher and Peck, 2004).

3) Supply Chain Agility

This step is about being prepared for disruptions and other unpredictable events. One of the most powerful ways of achieving resilience in the supply chain is, according to Christopher and Peck (2004), to create networks capable of more rapid response to changed conditions. Supply chain agility can be defined as: *the ability to respond rapidly to unpredictable changes in demand or supply* (Christopher and Peck, 2004).

Agility is founded on two key principles, velocity and visibility. Velocity can be seen as the total time it takes to move products and materials from one end of the supply chain to the other. It can be measured as the time from when the focal unit places an order from its first suppliers to when it delivers to its customers. Focal unit means: *the individual firm in the supply chain from the perspective of which the supply chain flow risk issues are seen, interpreted and acted upon* (Paulsson, 2007).

Visibility can be described as the ability to see from one end of the supply chain to the other. Visibility connects the first two steps, supply chain (re) engineering and supply chain collaboration. It makes it easier to understand the supply chain and thereby reducing uncertainty in the chain and secondly it reduces supply chain risk due to of shared information in the network (Christopher and Peck, 2004).

4) Creating a Supply Chain Risk Management Culture

Support from the top Management is important for creating a resilient supply chain. Risk culture is the set of shared attitudes, values and practices characterizing how an entity considers risk in the day to day activities. A SCRM culture is created by policies and by good attitude amongst the management and executives. (Christopher and Peck, 2004). To help the company to achieve this, the management can establish an ERM philosophy and determine the company's risk appetite (COSO, 2003).

3.8 Crisis Management

The Institute for Continuity Management (DRII) applies an enterprise perspective of the definition of a crisis and their definition will be used in the thesis. DRII (2008) defines a crisis as: *a critical event, which, if not handled in an appropriate manner, may dramatically impact an organization's profitability, reputation, or ability to operate. Or, an occurrence and/or perception that threatens the operations, staff, shareholder value, stakeholders, brand, reputation, trust and/or strategic/business goals of an organization.*

Characteristics for a crisis are that actions and decisions will be taken under pressure and with limited input and time. The attention from media, employees and/or the public is usually intense.

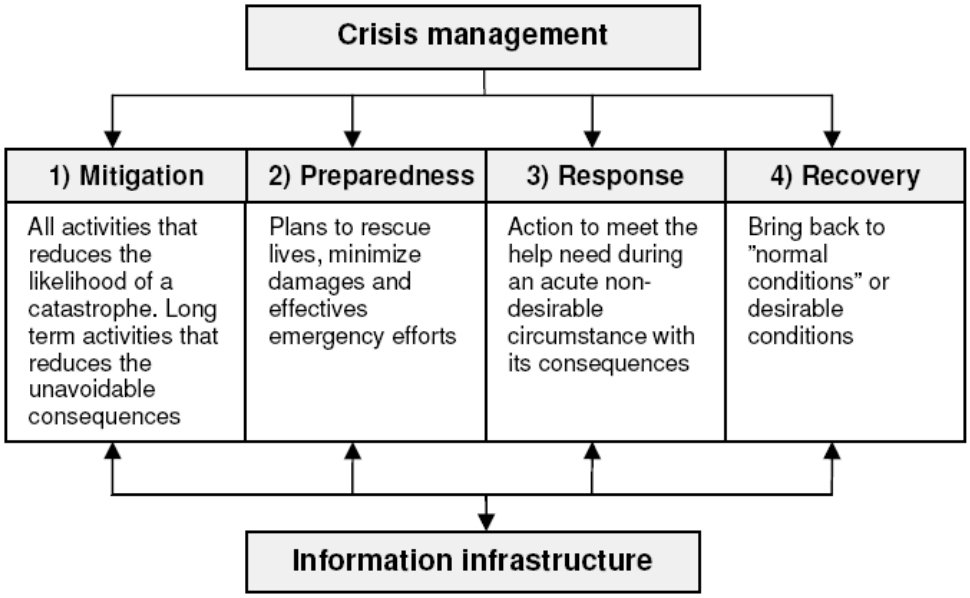

Figure 3.6: Crisis managements different part according to US Federal Emergency Management Agency (FEMA, 1997)

FEMA (1997) has divided crisis management into four steps, see Figure 3.6. The phases of mitigation and preparedness takes place before a crisis occur. The mitigation phase has a close connection to risk management, since it contains all those activities reducing the likelihood or consequence of a catastrophe. Risk analyses are often performed in this phase to investigate where to allocate risk reducing resources. The actions to respond to risks can be seen as the third and last step in IEC's risk management process.

Preparedness constitutes of the plans developed to rescue lives, minimize damages and effectives emergency efforts (FEMA 1997). Education of personnel in crisis management and setting up a crisis management team is part of the preparedness work.

The response phase contains necessary actions during a crisis (FEMA 1997). Here the response plans developed in the earlier phases shall be invoked and followed. It is important that actions are taken rapidly and that the resources are used coordinated (Abrahamsson and Magnusson 2004).

When the crisis is over the recovery phase starts and it aims to bring back the functions to normal conditions or to a more desirable condition (FEMA 1997). If recovery plans have been developed earlier they shall be put into action. If a catastrophe has struck many companies, those companies with available recovery plans can gain advantage over the others and in the end maybe increase their market share.

The information flow is a vital part of crisis management. It is important to have early warning systems, as it facilitates an early reaction (Abrahamsson and Magnusson 2004). There shall also be communication and feedback between the steps in the crisis management process. The learning from a catastrophe shall be used to strengthen the organization so it is better prepared to handle any future events.

3.9 Business Continuity Management

One problem with the risk management and crisis management processes is that in the risk identification phase it is difficult to detect all possible scenarios. Especially events with devastating consequences tend to be not foreseen just because they seem too unlikely (Andersen, 2003). A company which is not prepared for large catastrophes is very vulnerable. The trend today goes towards an increasing complexity of the world community with a deeper integration of networks in all areas resulting in an increased probability of unforeseen events to occur (Andersen, 2003). Therefore every company today has to be aware that an unforeseen event can occur and must be prepared to handle a crisis. This is the reason for the growing interest in Business Continuity Management (BCM), with focus on the process after an unforeseen event has occurred.

The Business Continuity Institute (BCI) Good Practice Guidelines (2008) defines BCM as:

A holistic management process identifies potential impacts threatening an organization and provides a framework for building resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value creating activities (DRII, 2008).

BCM is used on management level and the goal is to achieve a resilient business. The goal is achieved by identifying the potential impacts in advance. It provides a certain level of comfort in knowing that if a major disaster occurs, it will not result in financial disaster (Geoffrey, 1997). BCM can be seen as a subset of a larger risk management process within the area of Enterprise Risk Management (Krell, 2006). BCM has several similarities with risk management, but there are also some differences, see Table 3.3. The main difference between the two processes is that BCM focuses on which strategies and tactics to apply after an unforeseen event have occurred, and the objective is to restore the business normal operations to the lowest possible cost. The risk management process focuses on strategies to avoid or mitigate risks before they occur (Krell, 2006).

Table 3.3: Differences between Risk Management and BCM reproduced from The Business Continuity Institute, (2005).

	Risk Management	Business Continuity Management
Key method	Risk analysis	Business impact analysis
Key parameters	Impact and probability	Impact and time
Type of incident	All types of events – though usually segmented	Events causing significant business disruption
Size of events	All sizes (costs) of events – though usually segmented	For strategy planning, survival threatening incidents only
Scope	Focus primarily on risks to core-business objectives	Mostly outside the core competencies of the business
Intensity	All from gradual to sudden	Sudden or rapid events (though response may also be appropriate if creeping incident becomes severe)

A perspective on BCM was presented by FM Global (2007). According to them BCM can be divided into different phases of response which are illustrated in Figure 3.7. The content of each phase is described below.

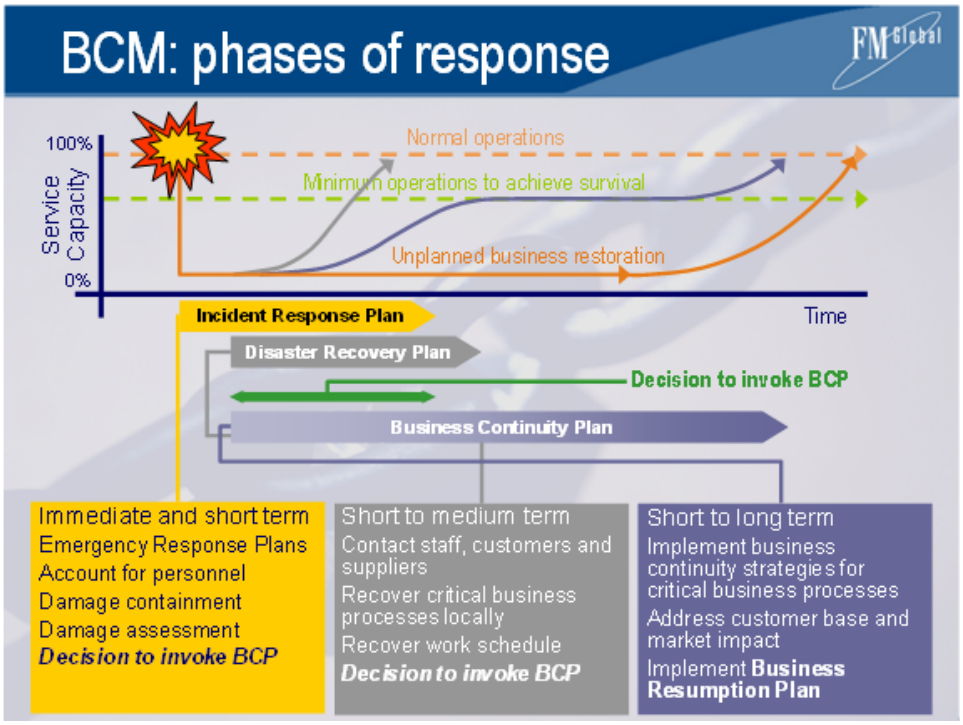

Figure 3.7: Phases of response in BCM (FM Global, 2007)

3.10 Business Continuity Planning

Business continuity planning (BCP) can be defined as: *a process of developing and documenting arrangements and procedures that enable an organization to respond to an event that lasts for an unacceptable period of time and return to performing its critical functions after an interruption* (DRII, 2008).

The content of the definition is that BCP shall be seen as one part of the whole BCM process. The purpose of BCP is to mitigate the effect of an unforeseen event. BCP focuses on the negative impact and the process after an unexpected event has occurred. The plan highlights what shall be done to get back to normal business as soon as possible and how to keep the losses to a minimum. A vital part of the BCP is to identify the company's critical business processes in a

holistic view and determine where more specific action plans (Incident Response- and Disaster Recovery Plans) and strategies will be needed and prioritized (BCI, 2008).

When there is a disruption, it is often too late to do anything very radical about it, unless you have taken action in advance. This is why the organizations have to work proactively. BCM means working systematically in advance to prevent disruptions from happening and if it happens anyway, the BCP shall consist of plans that get the processes quickly and safely back to order. This means that the action plans which are a part of the BCP will allow the organization to return to normal activity after a disruption has occurred.

An organization has thousands of different activities, but only a few percent of them are critical to the business. It is around these activities the specific action plans shall be directed, (Norrman & Lindroth, 2004). When first creating the plans, focus on the worst-case scenarios of the identified risks. Plans for the most serious consequences means also minor disruptions can be handled. (London First, 2003).

Gallagher (2005) described a model on which elements BCP shall include, see Figure 3.8. The model consists of seven steps which are explained below.

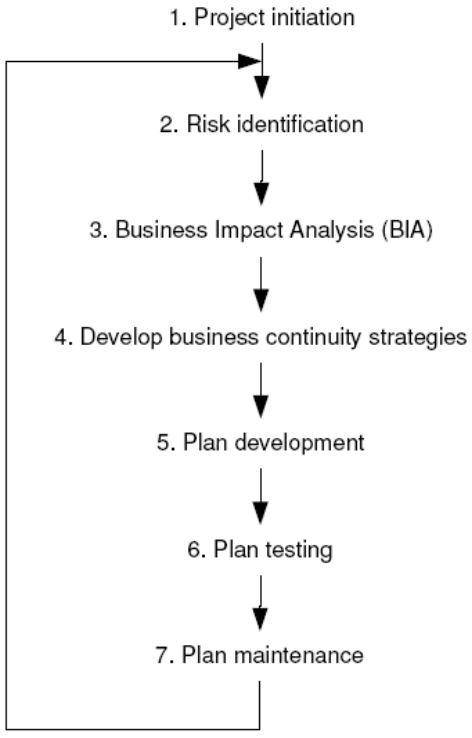

Figure 3.8: Seven phases which should be included in BCP according to Gallagher (2005)

1 Project Initiation

The initiation of the project is very important. Support from the management shall be established and the framework and scope of the project shall be decided. As mentioned above, in the chapter how to create a resilient supply chain, one of the conditions in creating a resilient supply chain is to get support from the top management. The same thing goes for BCP. If the project does not get fully support from the management it is likely it will encounter unnecessary resistance and perhaps even self die. (Gallagher, 2005)

2. Risk Identification

In this step a risk analysis is conducted to identify the main risks on company level and the impact and probability that they will arise (Gallagher, 2005).

3. Business Impact Analysis

The purpose of the Business Impact Analysis (BIA) is to identify which impact disruption and disaster scenarios has on the organization (Gallagher, 2005). The BIA will show which parts of a company that will be most affected by an incident and what effect it will have upon the company as a whole (State office of risk management, 2008). The BIA is the base the site specific action plans are based on. The critical processes which generate most value within a company have to be identified and documented (ASIS, 2005). The result of the BIA is a priority list of which business processes to restore first in occurrence of a disaster. To be able do achieve this some key factors has to be taken into consideration. This includes knowledge about which products generate the main part of the revenues, which are the key markets and which are the most important customers (FM Global, 2007).

4. Develop Business Continuity Strategies

The risk analysis and the BIA identify which parts of the organization are most vulnerable and important to the business. Based on those, continuity strategies will be formulated and specific plans will be developed to meet the needs identified in the risk analysis and the BIA (ASIS, 2005). The strategies can comprise policies for reducing the dependency on key suppliers or customers, human resources issues like succession planning, training, and retention of skilled workers, as well as the use of recovery centers and geographic dispersion of facilities and offices. The specific plans will focus more on actions to be taken when an unforeseen event has occurred. The development of business continuity strategies is a very important step in the development of the plan because a lot of people are involved and key managers discuss essential questions and priorities. In this way all people affected are aware of the strategies (Gallagher, 2005).

5. Plan Development

The development of the plan is individual for each organization. There is no general plan that fits all because every single organization is unique. The plan will therefore vary in size and layout depending on the needs and size of the organization (Gallagher, 2005).

6. Plan Testing

To discover weaknesses, to keep employees updated and to avoid that the plan results in a folder in the bookshelf it is important that the plan is regularly tested. One way to test the plan is to execute crisis training exercises (Gallagher, 2005). Exercising of plans validates the business continuity procedures and confirms that the people involved know what to do in the event of a disruption (FM Global, 2007).

7. Plan Maintenance

Changes occur constantly in the company's supply chain and in the environment. In order to assure that a company is always prepared for disruptions, it is therefore important that companies continually update their plans (Gallagher, 2005). If the plans are to complex with too many people involved, it is probable that they are less frequently studied. Therefore it is important that someone within the company is responsible for the main plan and to ensure that each entity in the company assign one person to be responsible for updating their plans (FM Global, 2007).

3.11 Action Plans within BCP

One of the key elements when developing business strategies (step four in Gallagher's model) is to create specific actions plan on how to respond during and after unforeseen events. The terminology within this area can sometimes be a bit complicated as different companies adopt different terminology for the same functions. According to FM Global (2007), recovery strategies can be divided into two phases, Incident Response Planning and Disaster Recovery Planning. The content of these plans will be described below.

3.11.1 Incident Response Planning

The first state when an unexpected event occurs is the emergency state. The first action plan within BCP is therefore the Incident Response Plan (IRP). Incident Response Planning focuses on instant actions that must be taken to prevent significant losses during a crisis. The plan is specific and unique for each site of an organization. The plan serves as a guidance manual during crisis on how to act properly for controlling the situation, saving and protecting lives, shutting down affected systems and preventing further damage (Sheffi & James, 2005). The IRP relates to phases in crisis management. The development of the IRP relates to the preparedness-phase and if the IRP gets invoked it relates to the response-phase.

3.11.2 Disaster Recovery Planning

The Institute for Continuity Management (DRII) defines Disaster Recovery as:

The ability of an organization to respond to a disaster or an interruption in services by implementing a disaster recovery plan to stabilize and restore the organization's critical functions

A Disaster Recovery Plan is further defined as*: the management approved document that defines the resources, actions, tasks and data required to manage the technology recovery effort. This is a component of the Business Continuity Management Program.* (DRII, 2008).

The DRP ought to have a general approach, which means it is functional regardless of what type of crisis happens. The DRP has it focus on how to act on short to medium term after a disaster has occurred. Important tasks for a DRP are to contact staff, suppliers and customers and to recover critical business functions locally. It is vital that the responsibilities within the DRP are clarified so everybody knows their task during the crisis. The DRP shall be invoked when the damage of the crisis has been assessed. This means that it is possible that both the IRP and the DRP are running simultaneously. The case could also be that the IRP is closed before an assessment of the damages is completed and the DRP can be invoked. A Disaster Recovery Plan (DRP) is specific for a certain site and therefore every vital location within a company should have a unique DRP. (FM Global, 2007)

The foundation of the DRP constitutes of the BIA developed specific for a certain site. The BIA has input from three sources; the Risk Analysis, the Business Model Analysis and the Financial Analysis, see Figure 3.9.

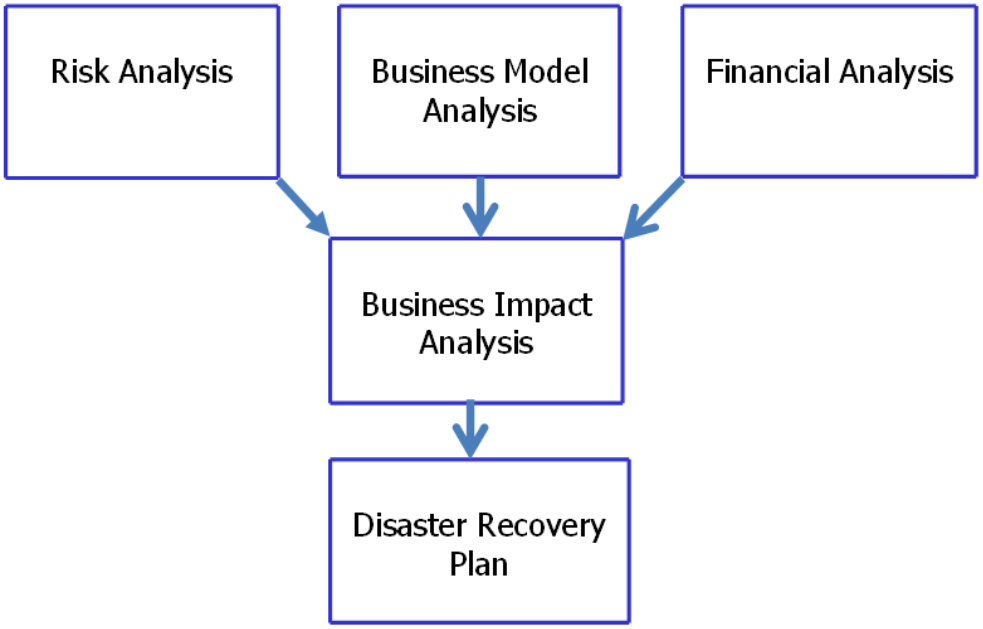

Figure 3.9: The Disaster Recovery Plan Process (FM Global, 2007)

The risk analysis identifies the key hazards at the site, estimates the probability and impact and suggests mitigation actions as described in chapter 3.3. The results from the risk analysis are used to determine risk reduction measures in order to reduce vulnerabilities (Nosworthy, 2000).

A condition for the further steps is to have a comprehensive understanding of the business. Knowledge about the business strategic objectives is vital. It is advantageous to create an overall model of the business, where the flow of products and services through the internal and external supply chain are visible. This part is called Business Model Analysis (BMA). (FM Global, 2007)

A financial analysis is the third input to the BIA. It contains information of how much profit different groups of products and services generates and what costs are associated with their delivery to customers. There are different types of costs that have to be taken into consideration in the BIA (ASIS, 2005). The most obvious cost to assess is the financial cost, which includes equipment and property replacement, downtime overtime pay, lost sales, regulatory fines etc. Another considerable cost is the damage of corporate image, because of negative press. The result will be deteriorated brand and reputation, which in the end leads to loss of customers and decreasing revenues. Employees, suppliers, customers and other stakeholders may suffer from physical and psychological harm which taken together represents a human cost (ASIS, 2005).

Based on these financial numbers an estimation of the measures MTO (Maximum Tolerable Outage) and RTO (Recovery Time Objective) for critical services and processes can take place. MTO states for how long a process can be nonfunctional before impacts become unacceptable. RTO is the target time set for resumption of product and service delivery after an incident (FM

Global, 2007). RTO ought to be less than MTO; otherwise measures have to be taken. These numbers have a central part in the development of the BIA. Another approach to estimate MTOs is to focus on the market/business aspect instead of financial numbers. This is a more qualitative sort of analysis and requires a comprehensive knowledge of the services and processes within the company. Relevant questions to answer can be: when will customers run away? When will the company loose credibility? When will dealers start looking for alternatives? When will our market share be damaged for a considerable time? The MTOs depend strongly of what type of good it is. Consumable goods tend to have a lot shorter MTOs than capital goods (ASIS, 2005).

The BIA specified for the DRP has a different scope compared to the one explained in the BCP process. The scope at this level is site specific, which means that the analyses is limited to those disruption and disaster scenarios that regards the certain site. The focal unit should still be the entire company, which implies that the impact shall be seen at company level. However the overall BIA is a good foundation also for the site level. The scenarios regarding the certain site should be chosen from the overall analysis and based on them develop a more detailed BIA with more scenarios (FM Global, 2007).

4. Case study: DeLaval Services GmbH

The chapter begins with a general presentation of DeLaval International AB. It contains a summary of how the case study at DeLaval Services GmbH was conducted and of some documented mini cases.

4.1 General Presentation DeLaval International AB

DeLaval International AB is a global company operating in the agricultural sector and is specialized in products for milk production. It all started for more than 125 years ago, when Gustaf de Laval in 1878 patented the world's first cream separator. In the year 1883 Gustaf together with Oscar Lamm founded the original company named AB Separator. A few years later, 1894 AB Separator acquired Hamra farm in Tumba, Sweden where the first tuberculosis free milk was produced already in 1901. In 1963 AB Separator changed name to Alfa Laval AB. In 1991 the Rausing family, owners of Tetra Pak acquired Alfa Laval AB and in 1993 the Tetra Laval Group was founded. In 2000 the group got its current structure when Tetra Pak sold Alfa Laval but decided to keep the dairy part (Alfa Laval Agri), which was named DeLaval.

Today the Tetra Laval Group consists of three companies; DeLaval, Tetra Pak and Sidel. The Rausing family consisting of Finn, Jörn and Kirstin is the sole owner. One of many advantages of being part of a family owned company is the long term commitment to the business. There are no short sighted shareholders to please and the family has a strong and historical interest in developing industrial solutions. In 2007 the total number of employees at Tetra Laval were 30 762 persons and the total sales was 10, 6 billion EUR see Table 4.1.

Table 4.1 Short fact about Tetra Laval group in 2007

Tetra Laval Group			
	DeLaval	**Tetra Pak**	**Sidel**
CEO	Joakim Rosengren	Dennis Jönsson	Mart Tiismann
Number of employees	4 407	20 859	5 496
Sales (EUR)	0,8 billion	8,6 billion	1,2 billion

Tetra Laval covers the whole value chain for milk products – from cow to consumer. The chain starts with DeLaval extracting the milk, transport, processing and finally packaging by Tetra Pak to the consumer. The Sidel Group designs, manufactures, assembles, supplies and sells complete

packaging lines for liquid foods packaged in three main package categories: glass bottles, plastic bottles and drink cans.

DeLaval's mission statements are:

- We drive progress in milk production.
- We aim to be at the cutting edge of the industry, to pre-empt farmers' needs through superior resources, technical expertise and service second to none.
- We will focus our attention on dairy farming as a whole and each individual farmer, whatever the size of their business and whatever environment they are working in.

As shown in Table 4.2 and Figure 4.1 DeLaval is a quite large company with a total number of employees of 4407 persons.

Table 4.2 Facts about DeLaval in 2007

Markets covered	>100
Customers	1 000 000
Local sales organizations	54
Portfolios	8
Employees	4407
Sales	0,8 billion EUR
Manufacturing units	18
Research and development units	3
Dealers	1240
Shops	1210
Sales representatives	1409
Service technicians	4155
Mobile shops and delivery trucks	571

DeLaval is a globally working company and has manufacturing units all around the world, see Figure 4.1. The head quarter is located in Tumba, Sweden. Since suppliers and customers are globally located, it means the supply chain becomes very complex. The core of the supply chain is the central warehouse and distribution centre in Glinde outside of Hamburg in Germany.

Figure 4.1: DeLaval´s manufacturing units around the world

DeLaval has a wide range of products and services. Similar types of product and services are gathered into a product portfolio. Totally DeLaval has eight product portfolios. Each portfolio is responsible for a group of GROSPs, which is a shortening of Group Sales Statistics and Profit Control. It is a system for sales statistic reporting. Each GROSP consists of a number of different articles, which are used in the manufacturing of products.

One of DeLaval's key products today is the DeLaval Voluntary Milking System VMS (see Figure 4.2) which was launched in 1998. The VMS is an automatic robot system where cows are milked automatically. During the milking the user has real-time access to monitor vital information such as cow ID, flow rate, milk yield, time, conductivity, possible blood contamination, volume and cleaning status.

Figure 4.2: The DeLaval VMS

4.2 DeLaval Services GmbH

The case study was performed at DeLaval's distribution center in Glinde where DeLaval´s logistic setup was studied closer. The distribution center belongs to DeLaval Services GmbH which is an affiliate to DeLaval International AB. DeLaval has three central warehouses in the world, one in USA, one in New Zealand and one in Germany. The one in Germany is the largest and is located at an industrial park in Glinde, around 15 kilometers east of Hamburg. The central warehouse is divided in four warehouses and three office buildings see Figure 4.3 and Figure 4.4.

The first weeks we held meetings with a couple of managers from the Logistic department, where they described in detail how DeLaval has arranged their logistic. The purpose of these initial meetings was to get a comprehensive understanding of the company and their logistic setup. During the meetings the managers explained logistic issues and we asked questions and tried to find out information would be needed to conduct a Business Model Analysis with a central warehouse in the center. These meetings implied that we got a good look into the transport strategies DeLaval applies and how the order management system works. We were encouraged to join on visits to external business partners. Meetings were held with all departments within the Logistic department to sort out their ordinary responsibilities. They were also asked to explain which their main tasks would be in case of crisis where the warehouse has limited capacity for an unknown time.

Managers within the Logistic department described in detail how DeLaval has arranged their logistic. We got a good look into the transport strategies DeLaval applies and how the order management system works. We were encouraged to join on visits to external business partners. Meetings were held with all departments within the Logistic department to sort out their ordinary responsibilities. They were also asked to explain which their main tasks would be in case of crisis where the warehouse has limited capacity for an unknown time.

DeLaval has three types of standard flows, which were analyzed in order increase the knowledge on how to create a general Business Model Analysis with the central warehouse in the center. The inbound flow to the warehouse as well as the outbound flow was studied more in detail. The part of the flow that does not pass the central warehouse was studied in order to be a base for alternative delivery solutions in case the central warehouse would have limited capacity.

DeLaval had two separate projects running which could be seen as different approaches to perform a Business Impact Analysis (BIA). The projects aimed to identify critical items to DeLaval's business on different approaches. Conclusions from these projects were drawn on how a general BIA can be developed.

In a later phase meetings were held with managers from the Logistic department in order to develop business recovery strategies. The meetings had the character of workshops and alternative delivery solutions were suggested and discussed. Organizational factors to take in consideration when establishing a Disaster Recovery Organization were also illuminated and analyzed. A conclusion was that it is favorable if the Logistic department at a company constitutes the base of the organization. The extra functions and teams that are needed can then be added to the organization.

The learning described above from the case study was used together with the theory presented in the previous chapter to develop the Disaster Recovery Planning Guide.

Figure 4.4: An air photo over DeLaval Services in Glinde

Figure 4.3: DeLaval Services GmbH. The brown buildings are warehouses, the orange buildings are offices. The white buildings belong to Alfa-Laval AB.

4.3 Mini cases

Further cases were studied in a general way to get a more comprehensive picture of risk related to the supply chain. The mini cases have worked as inspiration when creating the DRP-Guide.

4.3.1 Case ALPHA

ALPHA is producing and selling office furniture. All the manufacturing is outsourced, the productions therefore constitutes assembly of parts into a complete piece of furniture. The production is not very complex but ALPHA only has one production unit and the warehouse is located in the same building. The solution to have only one factory with both production and warehouse in the same building means that ALPHA is exposed to severe risk. The company has a few risk handling routines including a BCP, but their main focus are on how to prevent fire and how to react in case of a fire. Other possible risks and sources to disruptions are mostly neglected.

ALPHA is singled sourced with several of its suppliers. For example, they are singled sourced on components delivered from their most important supplier. In one occasion this supplier had a fire. When this happened ALPHA responded quickly and informed both customers and the media about the expected consequences. This was possible thanks to their business continuity plan.

4.3.2 Case BETA

BETA is a Swedish based company working on a global basis which manufactures a wide range of high-technology products. They offer products, solutions and services in the area comprising rolling bearings, seals, mechatronics, and lubrication systems. BETA has 110 manufacturing sites distributed all over the world and its own sales companies in 70 countries. BETA is also represented in 140 countries through some 15 000 distributors and dealers. BETA has implemented centralized warehousing as logistic setup and their European distribution center is located in Tongeren, Belgium. The central warehouse replaced 18 other warehouses in other European countries and covers 45 000 m^2. The capacity is 150 000 storage locations and shall supply a large part of the European market.

4.3.3 Case GAMMA

GAMMA is a big international company working on a world market with advanced high tech-based products for industrial use. They offer a number of products but one (product Anna) is economically dominant. This product contains advanced components and several of them are singled sourced. Most of the production of this product takes place in one of GAMMA ´s several production sites. GAMMA manages the marketing and distribution of this product.

Anna is produced tailor made according to customer orders meaning no buffer of the final product exist. The product is not unique on the market but for technical reasons it is difficult for customers to change manufacturer. Since the product also involves a quite large investment for the customers, it means that an investment has long-term consequences. It is therefore very important for the customers to have confidence in GAMMA ´s ability to deliver as ordered. A disruption which would damage the reputation of GAMMA ´s brand would lead to serious consequences for the company.

The fact that Anna is produced mostly at only one production site, which contains unique equipment that would take considerable time to replace if a disaster would occur, stresses the need for risk handling routines.

4.3.4 Case DELTA

DELTA is a medium-sized company working mostly on the European market and they are designing, producing, marketing and are selling high-priced, advanced design products of good quality. They have one big production site. All components are standard components of good quality, alternative suppliers can be found. Only standard equipment are used at the production site and the assembling of the components are basic. If the production site would be destroyed the production can therefore be started up in another site after just a few weeks. The products are sold in many markets through special shops that only sell DELTA products. The products are most of the times built to customer order and are therefore more or less unique.

4.4 Problem description

DeLaval is a global company which aims to serve customers all over the world. This means they are also sourcing from different parts of the world. As consequence DeLaval's supply chain has become very complex and widespread. DeLaval generates value to their business by delivering products and service to customer. The European market is DeLaval's largest and most important one. DeLaval has chosen to implement centralized warehousing as logistic setup, because of cost advantages. A majority of the total delivered volume of goods passes through the distribution center in Glinde. This implies that an unforeseen event at the distribution center can cause disruptions with widespread effects in the supply chain and consequently also to the business.

The four mini cases highlight different supply chain related vulnerabilities and shows that most companies today are vulnerable to disruptions in their supply chain. In case of a major supply chain disruption, the impact to the company's business is likely to be severe. These supply chain related vulnerabilities stresses the need of undertaking risk handling measures and being prepared for unforeseen events.

5. The Disaster Recovery Planning Guide

In this chapter the development of the guide is described. The structure of the guide is presented here. The preliminary guide is tested and changes are implemented.

5.1 Developing the guide

For developing the preliminary Disaster Recovery Planning Guide (DRP-Guide) we used the working procedure described in Figure 2.2. Studies of literature have provided us with the general theory in the field of Risk Management and Business Continuity Management which is necessary to establish a continuity plan. The case study performed at DeLaval in Glinde resulted in important knowledge of logistic issues for our specific situation with centralized warehousing. These two sources of input constitute the foundation for developing the guide.

Gallagher's (2005) seven steps model for Business Continuity Planning (BCP), see figure 3.8 in chapter 3.9.1, has served as a good starting point when developing the DRP-Guide. One difference is that the BCP is developed at company level, but the DRP is unique for the specific site. The BCP points out which functions/sites that are critical to the company and can emphasize the need of more detailed contingency plans for these critical functions/sites. The DRP shows which functions/processes are critical at a specific site. However, the two plans have the same target; to ensure business continuity and therefore the Gallagher's (2005) process for BCP should be able to apply on lower level within the organization.

Gallagher's (2005) first step, project initiation is logical to use when starting the DRP project. A planning framework for the projects needs to be established, where the basic conditions are stated. Gallagher (2005) emphasizes the importance of ensuring full support from top management. Top management's vital role in setting the risk culture and influencing other parts of the organization was also stressed by COSO (2003) and Christopher and Peck (2004).

Gallagher's sixth and seventh step regard plan testing and plan maintenance. These issues are handled in the first step of the guide as basic conditions, where it should be clarified how often the plan should be tested and updated and who is responsible for these tasks. The DRP-Guide shall be used to develop a DRP. Testing and maintenance of the plan shall take place on regularly basis after the DRP is finished to keep the plan alive. This is the reason why these steps from Gallagher are included in the first step of the guide.

Gallagher's second step, risk identification is not relevant in this case; since the guide focuses on how to mitigate the negative impact after an unforeseen event has occurred. Risk identification is a vital part of the risk analysis and ought to be undertaken when performing regularly risk analysis at the site.

Gallagher's BCP-process has a general approach, but our starting point is a very specific situation and therefore some additions have to be made. Since our situation regards a central warehouse it is absolutely necessary to get a comprehensive understanding of the business and the supply chain. Therefore the second step of the DRP-Guide comprises to conduct a Business Model Analysis (BMA). FM Global (2007) stresses the necessity of understanding the business well and performing a BMA. This was achieved in the case study at DeLaval in Glinde through several meetings with managers from the Logistic department, a study of the warehouse and visits to external platforms and split points. We have received relevant documentation regarding the logistic setup and collected information from DeLaval's intranet. With information from these sources we got the knowledge on how to create a BMA.

The Business Impact Analysis (BIA) is a central step in developing a DRP. Gallagher's third step concerns the BIA. FM Global (2007) and ASIS (2005) also point out the importance of conducting a BIA and the target with the analysis. DeLaval had two projects running which both concerned BIA. Learning from these projects enabled to perform the BIA at a more practical level and which possible approaches to use.

To structure a Disaster Recovery Organization with teams and responsibilities is a logic way of implementing the recovery strategies. To develop an organization for a crisis situation is one of the main things related to the preparedness phase in Crisis Management, see chapter 3.8. The case study at DeLaval in Glinde showed that DeLaval had a crisis organization in their Incident Response Plan. During meetings with managers from the Logistic department it got clearer which functions ought to be included in the Disaster Recovery Organization. A team was created for each major function and more specific tasks were discussed and developed for each team.

Developing recovery strategies is a vital step in the disaster recovery process and is similar to Gallagher's fourth step which is named develop business continuity strategies. The strategies are based on the output from the BMA and the BIA. The BMA shows alternative ways of the delivery of products and services from supplier to end customer, while the BIA determines which processes or products to prioritize. Recovery strategies can also handle more practical issues like ensuring there is a back-up facility equipped with all necessary tools, to work from in crisis situation. Discussions with managers from the Logistic department led to possible solutions to apply in a crisis situation.

The last step is to write the action oriented plan using the proposed plan structure, which is covered in Gallagher's step 5, plan development. All information required to write the plan has been compiled in the previous steps.

When developing the first part of the DRP-Guide, it was basic to consider how the different steps would be presented in the actual plan. This resulted in a preliminary main structure of the plan in part two. It is logic to start with the initial conditions and then build on with the other headlines.

The plan structure affected part 1 of the guide to better fit in with the plan structure. This is one of the reasons why Gallagher's sixth and seventh steps are handled in introduction chapter.

Of Gallagher's seven steps we have used four of them in our six-steps DRP-Guide. Furthermore Gallagher's sixth and seventh steps have been aligned in our first step, which means that we have used six of the seven steps in some way. It is only Gallagher's step two, risk identification, which has been rejected. The steps in the DRP-Guide not inspired by Gallagher are step two, BMA and step four, Disaster Recovery Organization. These steps were inspired by the other sources mentioned above and by the case study performed at DeLaval in Glinde.

5.2 Overview of the DRP-Guide

One of the objectives of the thesis is to develop a guide on how to mitigate the supply chain disruption risks of a totally destroyed central warehouse in a supply chain with just one central warehouse.

The DRP-Guide is developed to manage disruption risks at a central warehouse. The guide is mainly valid for companies that uses centralized warehousing as logistic setup and should be used and implemented at site level. Other companies that want to develop continuity strategies for their warehouses should also be able to benefit from it. The guide comprises two parts and an overview is shown in Figure 5.1. The most important content of each step is visualized in the figure. The first part contains a six-step working procedure on how to compile all necessary information to be able to conduct a DRP. The second part contains a plan structure which can be used as a point of departure when writing the actual plan. The complete guide can be found in appendix A.

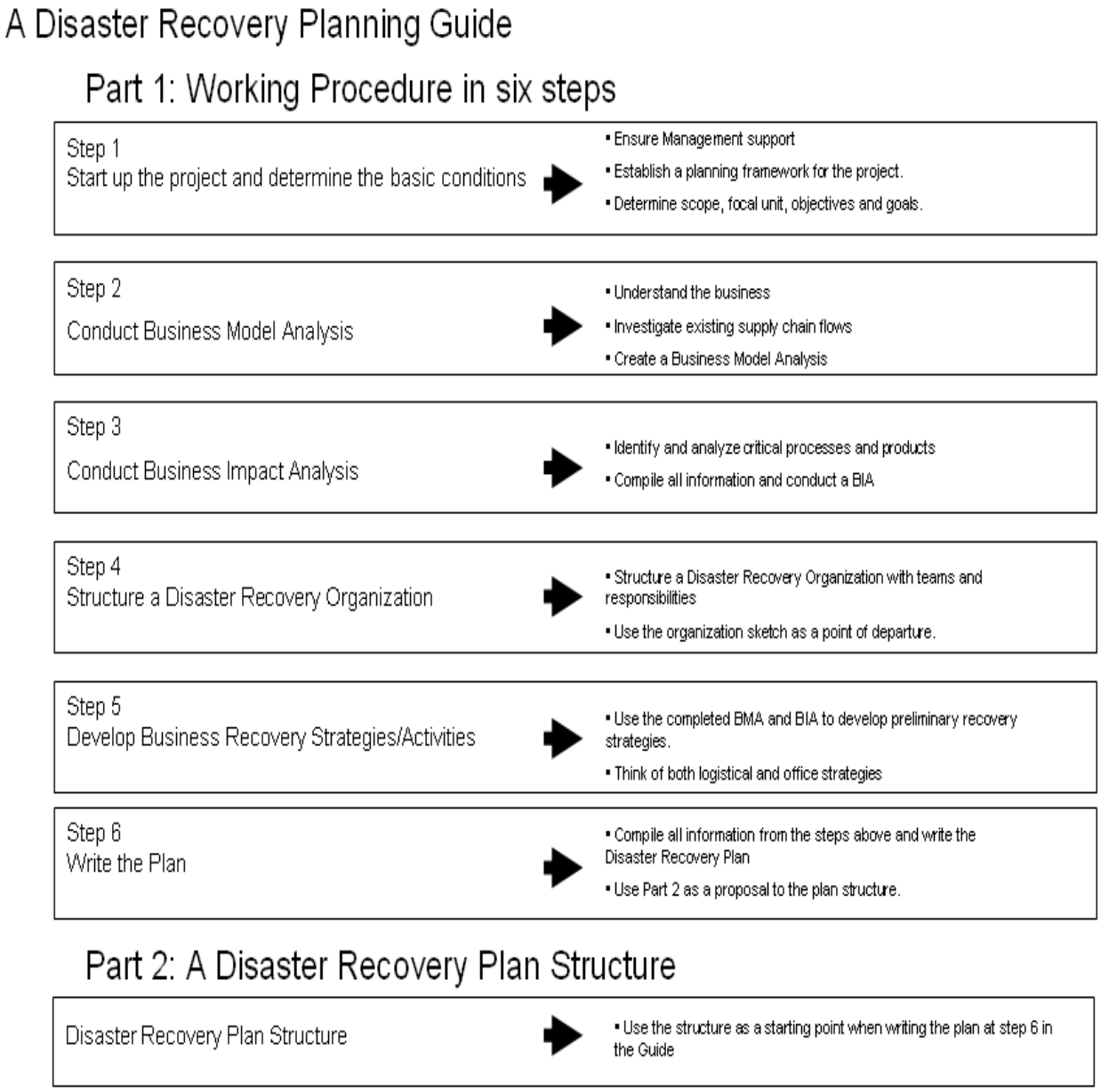

Figure 5.1: Overview of the Disaster Recovery Planning Guide

5.3 Test of Guide

To ensure that the DRP-Guide has scientific value, the preliminary guide needed to be tested. The purpose with the test was also to make sure that a specific DRP can be designed with help of the guide. In other words to test that the guide is useful and applicable where it was intended to be.

5.3.1 Working Method

The guide was tested on two external risk management consultants and one internal manager within DeLaval in Tumba. Since the guide was developed at the DeLaval site in Glinde it could not be tested on managers there. The test persons were:

- Lars Nilsson, former risk manager at Alfa Laval and started Alfa Laval's first captive in the 80s. Nilsson is well known within insurance and risk management and is now active within the Swedish Risk Management association SWERMA.
- Graham Goodenough, FM Global. Works as Senior Business Risk Consultant within Risk Consulting Group at FM Global.
- Göran Karlsson, Portfolio Director for Farm Supply & Barn Equipment and based at DeLaval's head quarter in Tumba. Furthermore he represents the portfolios in supply chain issues.

The test included the seventeen-page preliminary DRP-Guide. The academic report where all background theory could be found was also enclosed. The test included the following questions which we wanted the test persons to consider and give us feedback on:

- What are your thoughts about the overall structure of the guide?
- The applicability of the guide. Would it be possible to use the guide to develop a Disaster Recovery Plan?
- Logic build-up. Is the guide easy to follow?
- Any vital parts that are missing?
- More specific remarks?

To ensure that the guide is valid the procedure to develop the guide also has to be proven to be valid. Therefore all the assumptions made during the development of the guide were tested on DeLaval management and employees during the process. The tests took place during three follow up meetings with a core DRP group. The DRP group included DeLaval's Risk Manager, the Site Manager in Glinde, a Project Manager and an assistant to the Site Manager.

5.3.2 Compilation of Answers

Lars Nilsson wrote that the guide gives en excellent overall overview of most factors that would go into the development of a Disaster Recovery Planning process. He remarked that the guide requires a basic knowledge within risk management to be able to follow and therefore it would be rather difficult for non-experienced staff to use. He commented that the guide needed some overall restructuring to be more easily applied by a user and gave these suggestions for improvements: an overall process chart for the DRP-process, a local chart for each step, more frequent use of bullet points and stricter adherence of contents to chapters.

Nilsson wonders why the guide is not more generic and handles other unforeseen events than disasters. He suggests the possibility to focus more on Business Recovery and develop a more general model to simulate interruptions. He mentions that to talk about “disaster” can scare staff and customers and therefore it can be advantageous to use the term Business Recovery instead. There can be a risk for confusion why Incident Response Planning (IRP) is not included in the term Disaster Recovery. He also thought that various aspects and factors in some cases could be presented more structured and ranked in order of importance.

Nilsson points out the importance of using a holistic perspective in the guide. It is the business that is unacceptable vulnerable to disruptions in the warehouse, not the warehouse itself that is vulnerable. He stresses that the most important communication aspect is to inform clients of all kinds. He remarks that it is favorable if different business areas are involved in the Disaster Management Group, because it implies more powerful and faster decisions. Nilsson suggests that the next step could be to prepare an appendix where approaches and tools are recommended.

Graham Goodenough thinks that a step-process always is a good way to start a guide. However he would like the steps to provide a more project management framework. The guide should identify how the activities in the guide should be solved and by whom. The key activities would also need to be completed within a predetermined timeline which should be established in the plan. Goodenough thinks that the first step in the plan should not include details of the actual plan, but instead focus on identifying the data gathering process by establishing workshops, roles and responsibilities of key managers at strategic sites who are required to attend, establishing timelines for completion and conditions for administration and follow-up.

Goodenough points out that the guide is easy to follow but since no glossary of terms or definitions is located in the guide it can be difficult for people without DRP/BCP knowledge to use the guide. He likes the fact that the guide stresses the need to understand the business and underlines the importance of a BIA. However, he thinks that the BMA could be integrated as a step within the BIA. Furthermore, Goodenough thinks that the guide correctly outlines the need for specific activities for the teams to be stated, and it is good that this step refers to the BMA and BIA as key points of reference. Finally he thinks that the guide correctly advises on the need

to establish contact with suppliers, and indicates that a list should be maintained. The guide provides necessary information and references needed to establish assignments for individuals. He is fond of this level of guidance but thinks that it needs to be provided for other areas of the guide as well.

Göran Karlsson found the DRP-Guide very exciting, eye opening and useful for his organization. He thought the structure was easily understood and possible to implement and follow from a practical viewpoint. The logic behind it was easy to understand and follow. With basic knowledge and understanding of risk management he thinks that this guide can be used to build, document and create the organizational understanding of the plan, DRP. He remarked that one thing we should consider doing is to recommend how the plan should be stored and communicated to the organization and affected people, suppliers and customers.

5.3.3 Guide Revision

All the test persons remarked it requires some basic risk management knowledge to be able to follow the guide. We are aware of this fact and if something is unclear the underlying theory can serve as help. Nilsson requested some improved overall structuring of the guide. We have extended our initial figure to contain the most important task of each step, which will give a better overview of the guide. Nilsson questions why “disaster” is the only scenario that the guide regards and points out that to talk about the term “disaster” can scare employees within an organization. DeLaval has given us clear instructions to start from a worst case scenario and the term “disaster” is used because DeLaval has implemented FM Global’s framework within BCM. We believe when preparing for the worst case scenario one will also be better prepared for many minor incidents.

Goodenough expresses a wish to make the guide more detailed and establish a project management framework with a timeline and determined responsibilities. It has been our goal to make the guide rather general since every organization is unique and the guide should be able to be applied by different types of organizations. We think that to develop a more detailed project management framework is a good approach in supporting the single organization to develop their DRP. The guide could easily be customized to fit the single organization’s demands. But on an overall level we push a more general approach.

Karlsson mentions the importance of communicating the DRP to all affected people. We agree that this is a condition to be able to benefit from the plan. We believe that it ought to be the plan owner’s responsibility to communicate the guide and assure that it is stored in a proper way.

6. Discussion

This chapter contains a discussion on how the objectives of the thesis are met and how the purpose is fulfilled. The applicability of the guide and possible areas for future research are discussed.

6.1 Meeting the Objectives

The objectives of the thesis were:

- To penetrate how supply chain disruption risks of a totally destroyed central warehouse in a supply chain with just one central warehouse can be identified, evaluated and structured.
- For such a situation develop a guide that helps to generate new alternatives, for the delivery of products and services from supplier to end customer, and mitigation of the negative impact on such disruption risks.

The working procedure to collect the necessary input for writing the guide can be seen as the way of meeting the first objective. One needs to have a comprehensive understanding of the business to be able to identify the supply chain disruption risks of a totally destroyed central warehouse. To conduct a Business Model Analyses is a tool to achieve this. To evaluate the risks and know what to prioritize, one needs to know which business processes that are most critical to the company. To undertake a Business Impact Analysis is a way to manage this and will facilitate comparison and evaluation of risks. To document the work and put it in to a plan implies that one structures the developed procedures. It creates a better overview of different risk factors and makes the company more prepared to manage any unforeseen supply chain disruption.

The developed DRP-Guide fulfills the second objective. The DRP-Guide suggests how to find alternative delivery solutions for product and services from supplier to end customer.

6.2 Fulfilling the Purpose

The purpose of the project was to: *contribute to the knowledge on how disruption risks in a supply chain with just one central warehouse can be effectively managed.*

The developed DRP-Guide is a way to manage disruption risks in a supply chain with just one central warehouse. The DRP-Guide proposes a structured working procedure to use when

creating a DRP. Because of this reason and that the objectives are assessed to be met the authors consider the purpose of the thesis fulfilled.

6.3 Further outcomes of the thesis

A comparison between centralized- and decentralized warehousing was summarized in table 3.1 by the authors. The table contains the most vital advantages and disadvantages of respective logistic setup. The trend the last years towards centralized warehousing has been based generally on cost advantages. The table highlights that centralized warehousing is advantageous in most cost aspects, but increases the vulnerabilities within the supply chain. Decentralized warehousing is to prefer from a risk perspective and facilitates the managing of disruptions within the supply chain.

6.4 Applicability of the Disaster Recovery Planning Guide

The DRP shall be developed at site level, but can involve resources from other sites within the company. It is preferable that the Risk Management department runs the project with support from the Logistic department. If a Risk Management department does not exist it is logical that someone within the Logistic department undertakes the project.

The DRP-Guide is developed to be used at a central warehouse. It can also be applied on other warehouses. The need for DRP is however largest at a central warehouse because of the inherent vulnerability of such a logistic setup. It should also be possible to use parts of the DRP-Guide at manufacturing units as well.

It could make sense to align the DRP with the Incident Response Plan (IRP) to cover the entire time period after a disaster. DeLaval uses FM Global's recommendations in risk- and insurance related issues and they propose the development of two separate plans. An IRP had already been implemented at DeLaval Services GmbH in Glinde. This is the reason why the DRP-Guide focuses on the recovery phase and excludes those more acute elements that are handled in the IRP.

The DRP-Guide was tested on three competent persons involved in risk management and logistic activities. In order to make the DRP-Guide even more valid a more extensive test of the guide could be performed. Due to the time horizon of the thesis and difficulties in finding appropriate test persons, this was unfortunately not possible.

6.5 Future Research

The delimitations for the thesis have been rather strict and it would be possible to develop the DRP-Guide to be more generic and include other scenarios than disasters, which can be seen as a

worst case scenario. The worst case approach gives however a good view of how to act if minor disruptions should occur. If a more generic guide should be developed the subject would be Business Recovery rather than Disaster Recovery. Disaster Recovery can be seen as Business Recovery for a worst case scenario.

It could be possible to develop more detailed instructions to each step in the DRP-Guide. Proposals on approaches and tools to use can be recommended to facilitate the development of a DRP. A more detailed project planning framework can be established to serve as an extended guidance for the project leader. This framework may have to be customized to fit the single organization, but the overall view could be developed.

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Appendix. A Disaster Recovery Planning Guide

This guide for Disaster Recovery Planning (DRP) is developed to manage disruption risks at a central warehouse. The guide is mainly valid for companies that uses centralized warehousing as logistic setup. Other companies who want to develop continuity strategies for their warehouses should also be able to benefit from it. The guide comprises two parts see Figure A.

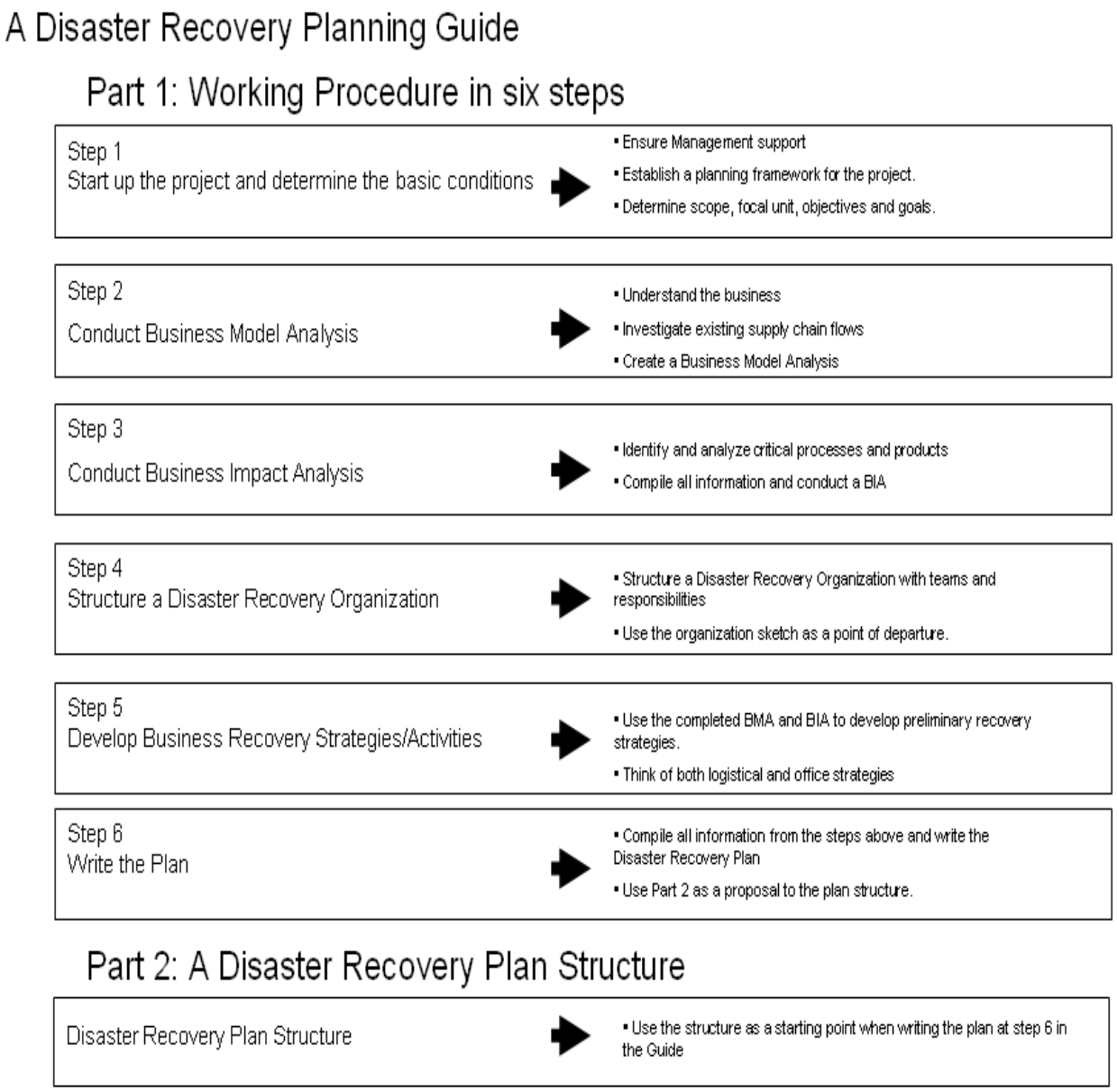

Figure A: Overview of the Disaster Recovery Planning Guide

The first part shall be used to gather all necessary input that is required to write the plan. The second part proposes a structure to use when writing the plan in the sixth step of part 1. It can be advantageous to have the structure in mind when conducting the first part to see which headlines the steps are connected to.

The Context of Disaster Recovery Planning

The work with DRP shall be seen as part of a larger Risk Management process which the company is undertaking. The DRP focuses on how to mitigate the negative impact of an unforeseen event and consequently also reduce the risk. Furthermore it is necessary that the company performs other activities in the field of risk management. Such activities can include conducting regularly risk analysis with a qualitative approach of the central warehouse. One result of such a risk analysis can be that the business is unacceptable vulnerable to disruptions in the warehouse. This fact can stress the need of a DRP for the facility.

The DRP focuses on how to restore the business after a disaster has occurred and shall not manage tasks that are related to mitigating the extent of the disaster. These tasks ought to be included in an Incident Response Plan (IRP), which has focus more on the acute phase of the crisis. The IRP's tasks involve evacuation of personnel, dealing with authorities, organize salvage teams and communicate the early development of the crisis both internal and external.

Part 1 – A working procedure in six-steps

This section contains six-steps for developing a Disaster Recovery Guide.

Step 1 Start up the project and determine the basic conditions

A planning framework for the project needs to be developed before the project can take off. A preliminary timeline shall be established; where it is stated when the project shall be finished and when milestones shall be reached during the process. Also clarify which resources the project demands from the organization and which members the project shall include. The plan owner and project leader shall be appointed. Below follows the conditions to be decided upon in the first phase of the process to develop a DRP.

Scope

One of the first things to be decided is the scope of the plan. The site shall be defined and also which functions/departments within the company are located there.

Define Disaster and Conditions for Invoking the Plan

Determine what defines a disaster for your company. It is vital to know under which circumstances the Disaster Recovery Plan shall be invoked. If your company has a clear definition of a disaster it facilitates the decision to invoke the plan or not. Determine also who has the authority to invoke the plan. It is appropriate that a group of people in the top of the Disaster Recovery Organization has this authority. It is important that not only one person has the authority while this person can be out of office.

Focal Unit

Decide which the focal unit of the plan shall be. Shall the impacts that regard the entire company be considered or shall it be just those impacts that concern the actual site/departments. It is often logic to have the entire company as focal unit or the entire group, because the negative impacts of a disaster at a specific site usually concerns other entities of the company as well.

Objectives and Goals

State the primary objective of the plan. It ought to include that the plan shall ensure the continuity of critical activities in the event of a disaster and reduce the disruption of the company's business.

It can be favorable to list some more specific goals for the plan. The goals can take up how fast the operations shall be resumed at a stand-by facility and for what time horizon the operations can run at the stand-by facility. The goal can also be to minimize the cost for the disruption.

Ensure Management's Support

One basic condition for the success of the project is to ensure full support from top management. The management attitudes influence the internal environment within other parts of the organization. If there is a good risk culture influenced by top management it facilitates the support the project will get from other parts of the organization as well.

Project Perspective

The plan shall focus on the product flows, where a product is defined as something one gets paid to deliver. It can be a physical product, a service or a mixture of both. The project shall have a result-orientated perspective where only business profit impacts shall be considered. To take other approaches in consideration that do not have any impacts on the business profit would not be adequate in the corporate world. The target for any business is to deliver products and services to markets in order to generate value for stakeholders. The development of a DRP is a way of guaranteeing the continuity of the value creation.

Testing the Plan

Decide how often the plan shall be tested. Testing the plan regularly helps to discover weaknesses and keep employees updated on what actions they have to take in the event of a crisis. To execute exercises is an accepted way of testing the plan. It is favorable to test the plan soon after it has been approved so every team knows their responsibilities.

Maintenance of the Plan

Decide how often the plan shall be reviewed and updated. The business environment is constantly changing so the plan has to be updated regularly. How often this should be done is individual for every company depending on the conditions. It is important however that the responsibility for updating the plan is clarified.

Step 2 Conduct Business Model Analysis

One of the conditions when developing a DRP for a specific organization is to understand the business. One of the first steps to achieve that can be by creating a Business Model over the existing supply chain flows. The model shall visualize the flows, according to this guide the product flows, and thereby make it easier for the plan developer to understand the business. The model will also provide a good framework for upcoming solutions when alternative strategies to redirect the flows are investigated. A lot of basic input regarding the logistic setup of the organization will be needed.

Start by creating an overall picture of the supply chain with the warehouse in the center. It is likely that your organization has categorized the product flow in some way. This categorization ought to be based on the different delivery strategies your company has applied for different types of products and related services. Try to describe these standard flows and visualize them in a general model.

The next step will be to investigate the physical flow from the warehouse's perspective. This can be done by visualizing the inbound and outbound flows of the warehouse. From where are the inbound goods being delivered into the warehouse and to where are outbound goods being delivered? It is common that an organization uses different delivery alternatives to transport their goods to the end customer. Visualize all these alternatives in the model. An example of a BMA can be seen in Figure B.

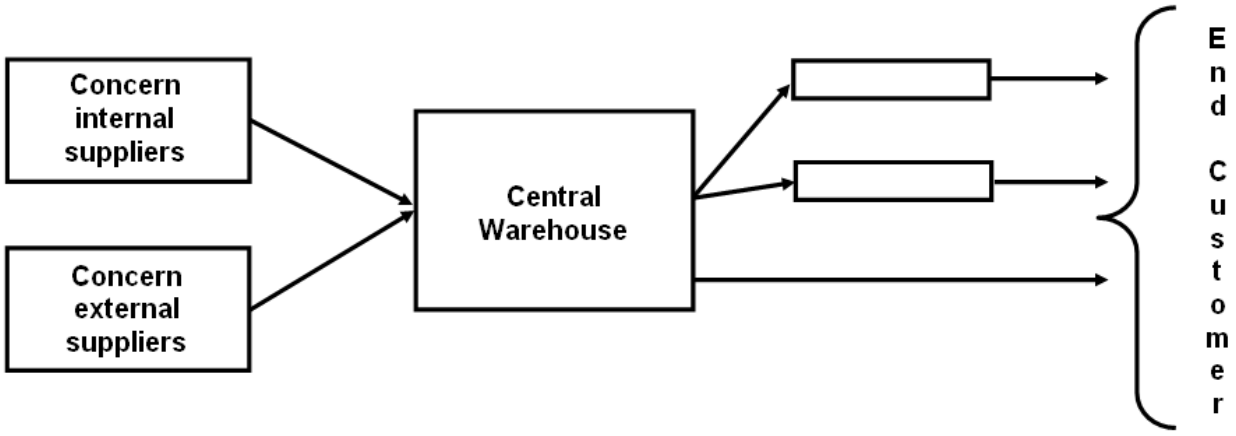

Figure B: Example of a general Business Model

Step 3 Conduct Business Impact Analysis

In a crisis situation the resources are scarce. It is impossible to solve everything at once during a crisis. Therefore it is vital to be prepared and to know where to direct these scarce resources. To know where to direct resources, you must determine which activities are critical for maintaining continuity and achieving your strategic objectives. The Business Impact Analysis (BIA) aims to identify which impact different disruption and disaster scenarios have within the organization. It will show which part of the company that will be most affected by an incident and which the critical processes are within the company. The outcome of the BIA is a priority list of which business processes to restore first in occurrence of a disaster.

The BIA shall be site specific. The analysis shall be limited to those disruption and disaster scenarios for a specific site. If a BIA has been conducted on company level it can serve as a good foundation for this site specific one. The scenarios for the certain site can be selected from the overall BIA and based on them a more detailed analysis with more scenarios can be developed for the site.

It requires a lot of input to conduct a BIA. Financial information and risk parameters need to be considered for identifying the most critical processes in the company's business. Financial numbers that can be interesting are how much value different business processes generate, which costs are arising as a consequence of the disruption. These costs can obviously refer to financial costs e.g. equipment and property replacement, downtime and lost sales. Another cost is the damage to the corporate image, which may result in a deteriorated brand and reputation. There can also be human consequences, which are costs associated with employees suffering from physical and psychological harm.

Maximum Tolerable Outage (MTO) for the identified processes shall be estimated. This can either be done by looking at financial numbers or in a more qualitative way by analyzing the market/business aspect of the disruption. Relevant questions to ask can be: When will customers run away? When will the company loose credibility? When will our market share be damaged for a considerable time? Please observe that there is usually a difference between consumables and capital goods in question of MTO, where consumables tend to have a lot shorter MTO.

The processes level of criticality need to be investigated. Apply a system approach to analyze dependencies between different processes. Furthermore look at how processes and products are sourced, if they are single or multiple sourced. In a crisis situation with a destroyed central warehouse it can be important to rapidly get new deliveries from the suppliers. Then it is of big importance what sourcing strategy your company has applied. Investigate if there are any products that are unique, which means that the product is only manufactured by one single supplier. In a crisis situation it can be difficult for that supplier to fulfill your demand and as a result of that you can have a disruption in your supply chain.

The last step in conducting a BIA is to compile all the information gathered about the processes and assess their criticality to your company's business. Rank the processes and establish a priority list of which processes shall be restored first in a crisis situation.

Step 4 Structure a Disaster Recovery Organization with teams and responsibilities

It can be an advantage to structure a Crisis Management Team or a Disaster Recovery Organization before the work with deciding recovery strategies starts. It facilitates the work with the recovery strategies since an organization visualize which resources are available at the site and it also provides a framework when deciding who is going to be responsible for the recovery strategies.

Start with a general sketch of the teams, pointing out the foundation of the Disaster Recovery Organization. It shall at least contain a Disaster Team Leader or Management Group, a Communication Team, a Warehouse Team, an Office Team an IT Team and a Damage Assessment Team, see Figure C.

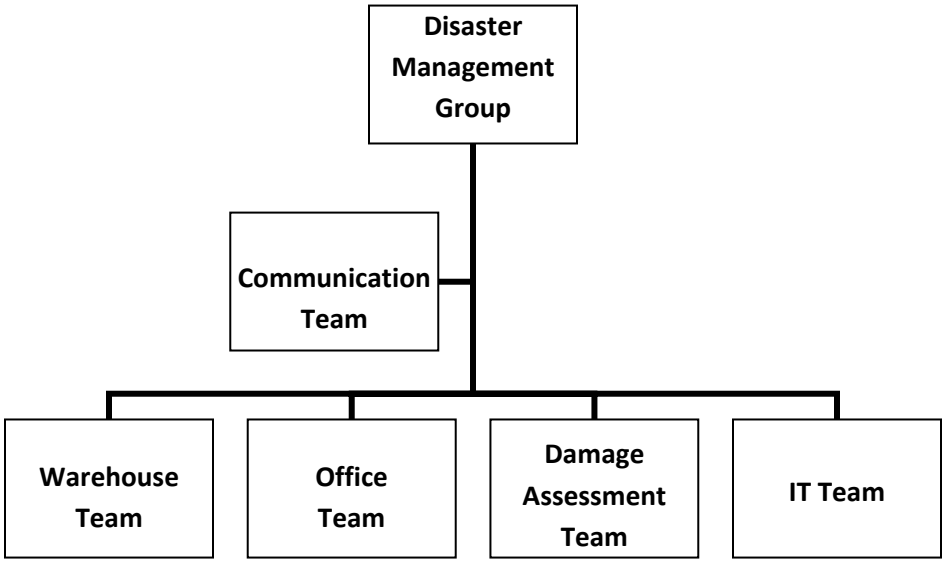

Figure C: Sketch over the vital parts in a Disaster Recovery Organization

When the team structure is ready the main responsibilities for each team shall be decided and stated. The main responsibilities are specific for every company, but some are general and can be applied on almost every organization.

The Disaster Management Group

If the team shall be managed by one team leader or by a management group with a specified team leader is depending on the size of the organization. If the organization is not very small it can be an advantage to use a management group. During the recovery phase of a crisis several critical decisions have to be taken and a management group makes it possible to discuss problem with several approaches and thereby avoid rash decisions. One solution can be to have a dual structure of the group and let some of the team leaders from the first subcategory teams be included in the management group. The group will then include leaders from each important area of the organization and let them have influence on the decisions.

The primary roles and responsibilities of the Disaster Management Group are:

- Receive an initial assessment of the nature and extent of the problem.
- Decide whether to invoke the Disaster Recovery Plan.
- Alert all the teams and coordinate recovery operations.
- Brief all the recovery team leaders and make sure they understand their roles.
- Monitor recovery operations and ensuring that the schedule is met.
- Document recovery operations.
- Keep financial structure, Set up an account and gather all costs and expenses related to the crisis. This will be needed for loss adjustment with your insurance company.

- Ensuring that appropriate arrangements are made to restore the site and return to normal.
- When the warehouse and office functions are restored at the primary site the group shall declare that the Disaster Recovery Plan is no longer in effect.

One final responsibility for the Disaster Management Group not to forget is debriefing. In the aftermath of a crisis it may be good to debrief those who were involved in or affected by the crisis. Some may have experienced scenarios which caused them feeling guilt or deep sorrow which they could not manage during the crisis but may come back to them later. If this is not treated it is possible that the business will not recover due to key members being unfit to continue their work. Debriefing is also a way to mitigate the human costs after a crisis.

The Communication Team

A Communication Team shall work very close to the Disaster Management Group. Both the internal communication and external communication is very important and therefore these tasks shall be visualized as a team in the organization.

The Communication Team shall be responsible for informing all employees about the situation, the action being taken and temporary instructions. They shall also notify the senior management of the disaster, recovery progress and problems and keep them updated during the crisis.

It is very common that organizations have a designated spokesman to handle the external communication. If this is the case at your organization then the Communication Team Leader shall be responsible to brief this spokesman and keep him/her updated on the situation. If your organization does not have a designated spokesman this team shall be responsible also for the external communication. However this is an extensive task and special policies to handle the external communication should be created.

The Damage Assessment Team

If the Disaster Management Group declares a crisis the first thing that has to be done before all the other teams can start their work is a damage assessment. The Damage Assessment Team shall evaluate the extent of the problem and compile a comprehensive picture of the situation; what has happened? What is the status of the warehouse and of the associated offices? When the extent of the damage is known the team shall report to the Disaster Management Group and the recovery process can begin.

The Damage Assessment Team shall work in cooperation with a Salvage Team and try to assess the period of interruption to operations due to the damage and the need of alternative premises both for the warehouse and the office function. The Salvage Team main task is to reduce

property damage. This team belongs to the Incident Response Team which focuses more directly on the acute phase of the crisis and will therefore not be more specifically mentioned in this plan.

The Office Team

The Office Team is responsible for making sure that office locations are available at least for those who really need it (this is specified in the next step). The Office Team shall be able to find an office facility very quickly for the Disaster Management Group in the short run so they can set up a command centre. They shall try to find an office solution that will last in the long run until the regular office is back running again.

The team is also responsible for making sure that all necessary equipment shall be available at the alternative facilities. The team shall in conjunction with the Disaster Assessment Team conduct an asset inventory were they make a full evaluation of the damage at the regular office and identify all potentially salvageable equipment. The salvageable equipment, items and documents shall be removed from the disaster area.

The Warehouse Team

The Warehouse Team surely needs to be divided into sub-teams. When creating the different warehouse teams try to make the structure as similar to the regular organization structure as possible. To make the recovery teams work effectively it is vital that the team's tasks are as similar to their daily work as possible.

The tasks of the Warehouse Team can be divided into two general teams where one team focuses on the strategic issues and the other team focus on operational issues. The strategic team shall focus on finding new solutions for the supply chain like search for alternative ways of delivery of goods from supplier to end customer and try to organize a temporary warehouse.

The other warehouse team shall focus on operational issues and try to achieve best possible order fulfillment. They shall be responsible for:

- Stop the inbound flow, contact forwarders and redirect them to alternative locations decided by the first warehouse team.
- Contact suppliers to describe the situation, cancel planned deliveries or ask them to increase there ability to fill up the stock levels again.
- Contact customers to decide new delivery dates and maintain the good relation with them. Keep them calm and tell them that they will be informed about the development of the situation.

- Find new delivery ways for the orders that have failed
- Administrate and monitor incoming orders.
- The team shall secure access to the prioritized items pointed out in the BIA, decide stock levels and make sure that these items are stocked as soon as a temporary warehouse is accessible.

These tasks usually belong to the logistic department and should do so also in a crisis situation. It does not matter if the logistic department is located at the specific site or at another site for example the headquarters, they shall still be included in the DRP.

The IT Team

IT-systems are today a necessity to make business. Without a functional IT-system the whole company would probably collapse. All of an organization's departments are more or less dependent on the IT-systems so therefore if something happens to these systems it is vital to have computer back ups. This part of the plan shall be constructed in close cooperation with the organization's IT department.

Step 5 Develop Business Recovery Strategies/Activities

In this section more specific recovery activities for each team shall be stated. A lot of people shall be involved in this process and key managers shall discuss and consider essential questions and priorities. In this way all people affected will be aware of the strategies.

Since the BIA points out what is most vulnerable and important for the business and the BMA provides a clear view of the business by visualizing the flows in the supply chain, these analyses are the points of departure when determining the more specific continuity strategies for the organization.

Logistic Strategies

Recovery strategies shall be created for every critical process pointed out in the BIA. Since this guide mainly is valid for companies using centralized warehousing the critical processes primarily constitutes of critical products stocked in the central warehouse. The main strategies shall therefore be on how to manage and redirect the supply chain flows of products. At this stage it can be an advantage to take a look at the BMA and start asking you the questions; what can we do if the central warehouse is totally destroyed? How can we redirect the flows? See Figure D.

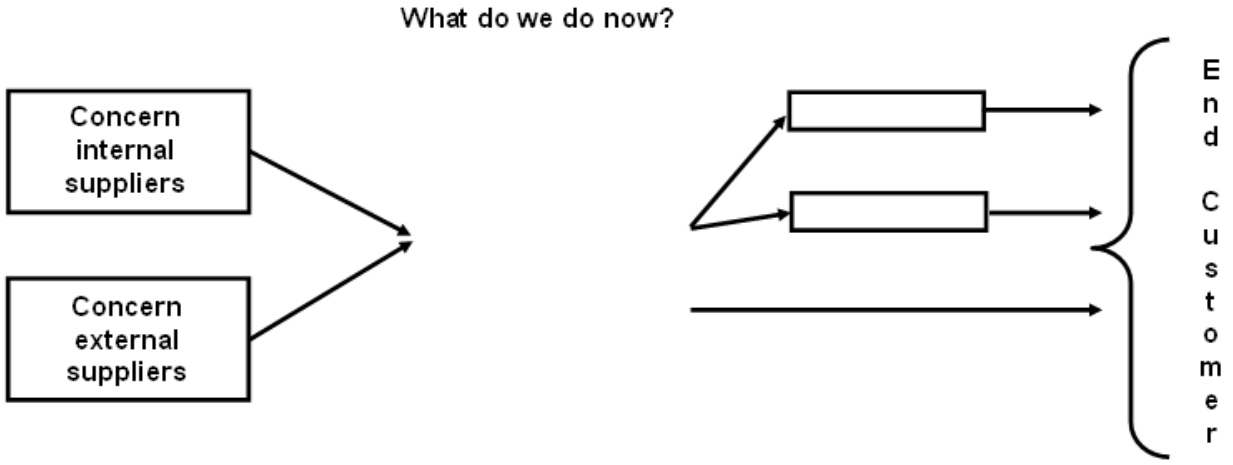

Figure D: Example of how to use the Business Model

The answer to those questions is again very specific for the single company but you can start investigate if direct deliveries from suppliers to end customers is possible. The investigation shall focus on the critical products from the BIA, see Figure E.

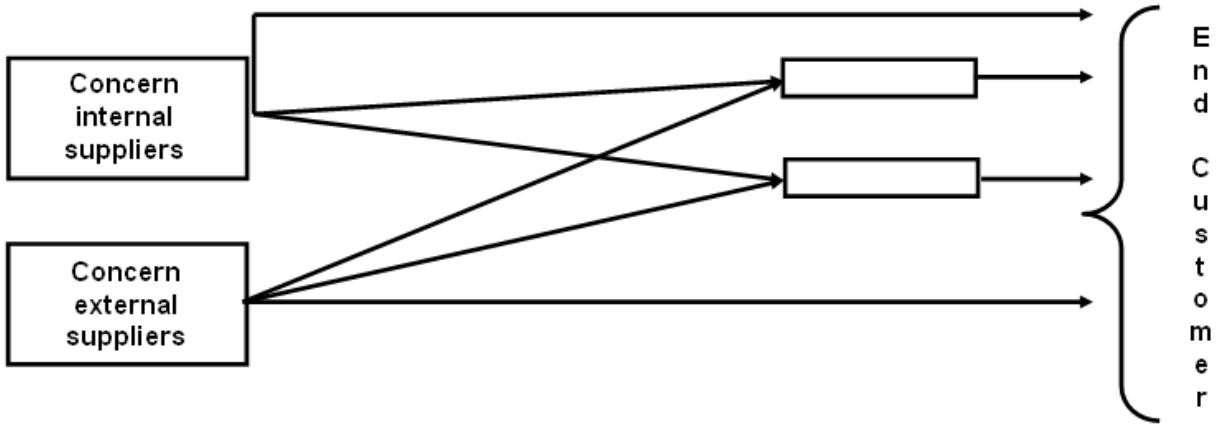

Figure E: Business Model with direct deliveries

The next step can be to investigate how your organization temporarily can store the critical products.

- Is it possible for your suppliers to stock items at their warehouses?
- Can the logistic providers stock items at their warehouse?
- Shall you build up a basic temporary warehouse and in that case what is the timeframe?
- Shall you contact warehouse hotels and rent space from them?

These are all examples of strategy questions you will have to investigate and try to find which solution fits your organization best, see Figure F.

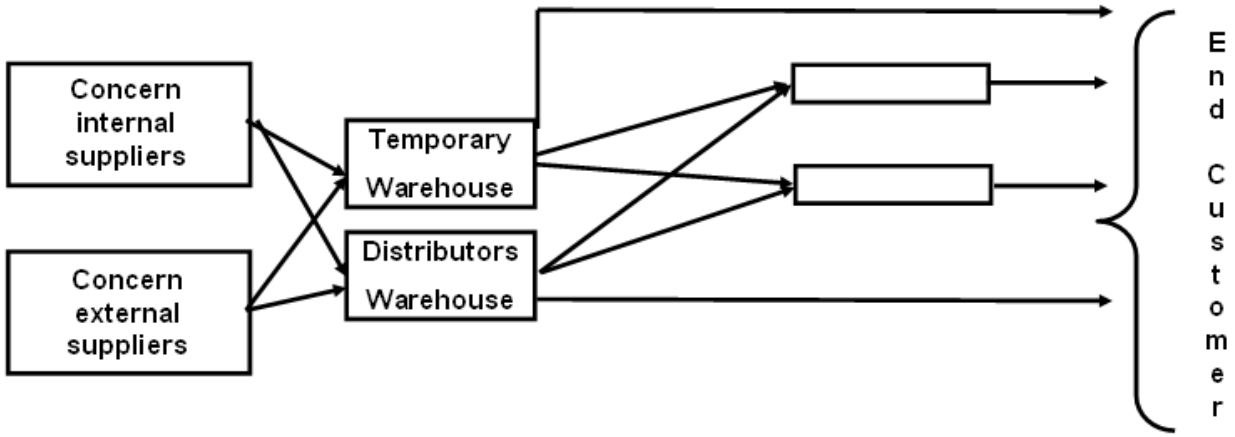

Figure F: Business Model with new alternative solutions for the supply chain

One of the important things for the operational warehouse team is to contact suppliers and customers. Which suppliers and customer shall be contacted, how they shall be contacted and by whom, shall be defined at this section. A contact list to the suppliers who delivers critical products and a contact list to the most important customers shall be created and put in an appendix to the plan. Being pro-active in contacting important suppliers and customers can help you to maintain good relations with them, strengthen your organizations brand and thereby reduce losses. Include those customers who would need and expect personal notification from you and those customers who would be offended or take their business elsewhere if they were not contacted.

The critical supplier list shall include:

- Name of the supplier
- Critical products or services. The list shall include a description over those critical products and services that the supplier delivers to you organization.

- Address
- Contact person's name, title and/or department
- Contact phone numbers. Include all possible ways to reach the vendor including fax, mobile phone and after working hour's numbers.
- Alternative names and numbers to the supplier. If the first contact person is unreachable it is good if an alternative is listed.
- Responsible person for the supplier at your organization.
- Comments. A field for comments can be used for information significant to this supplier, such as the reason this supplier shall be contacted following an incident, instructions the supplier would need or any appropriate notes.

The contact list to the important customers is similar to the supplier list and shall include:

- The name of the Customer
- Product or service you provide to them
- Address
- Contact person's name title and/or department
- Contact phone numbers. Include all possible ways to reach the vendor including fax, mobile phone and after hours numbers.
- Alternative names and numbers for the customer
- Responsible person for the customer at your organization. The person who is going to contact the customer shall be listed.
- Comments

Office Strategies

Strategies shall also be created for the associated offices to the warehouse. The strategies shall include both solutions for the short run and the long run. Long run solutions means a strategy that will last during the whole timeframe of the crisis, until the regular office is restored back to normal or until a new office is built up. The main priority for strategies in the short run is to make sure that the Disaster Management Group has access to some kind of office location so they can set up a command center. This command center shall be located within a short distance from the original site if possible. Start searching for internal solutions. If internal offices are located in the area contact them and make sure you get access to at least a conference room for the Disaster Management Group. The next step will be to organize short time solutions for all of the teams in the recovery organization and collect this information in a list.

If no internal solutions are possible one option can be to create a list with contact information to all the landlords in the area. This solution can be used as a starting point when searching for temporary facilities. It is not appropriate to list specific office locations with available capacity today since the accessibility of them constantly are changing. A list with all the landlords in the area can be an alternative when creating strategies for long time solutions. In this list your regular landlord shall be listed as contact number one. This can be an advantage since you already have a relation with him.

Step 6 Write the plan using the proposal for plan structure

The steps before have been all about the process how to gather information, how to compile the information for the analysis's, how to determine what needs to be included in the plan and the steps for achieving this.

Compile the steps above and produce the actual plan. To guide your organization on how to write the plan the next part of this guide will provide you with a proposal of a plan structure. The structure will show which headlines the plan shall include and a short description of the content. Please remember that the plan shall be action orientated and only include vital information. The reason why certain processes are unavailable is not the issue here.

Part 2 - A Disaster Recovery Plan structure

In this section a general proposal for a structure of the Disaster Recovery Plan is visualized.

1. Introduction

- Start with a short introduction explaining why it is necessary for your company to develop a Disaster Recovery Guide.

Scope

- Determine the scope of the plan. Define the site and which functions/departments are located there.

Objectives

- State the objectives of the plan and any possible specific goals.

Definition of disaster

- Define what a disaster means to your company.

Rules for invoking the plan

- Determine who has the authority to invoke the plan. State the rules of succession if that person is not available. Define criteria for when the plan shall be invoked.

Testing the Plan

- Determine how and when the plan shall be tested and appoint a person who is responsible for this.

Maintenance of the Plan

- Determine how often the plan shall be updated and appoint a person who is responsible for the maintenance of the plan.

2. Recovery Teams and Responsibilities

- Create an organization chart with the included teams. List every team's main responsibilities and tasks.

3. Critical Business

- Use the priority list from the BIA and describe which processes are critical to your business.

4. Recovery Activities

- List your logistic and office strategies. Describe which recovery activities to perform. Include alternative solutions both in the short run and in the long run. State a responsible team for every activity.

5. Related Documentation

- List relevant documentation which is connected to the DRP and which can be useful for your organization. For example such documentation can include the Incident Response Plan and the Insurance Manual.

6. The Teams

- The final part of the plan shall contain a list with all teams and their members. To facilitate the updating procedure of the plan, the team members shall not be stated anywhere else in the plan. Enclose contact information for the team members so it is

possible to contact them at work as well as after working time. A suitable template is visualized below in Figure G.

Disaster Management Group		
	Name	Telephone number
Team Leader		Office: Mobile: Private:
Assistant		Office: Mobile: Private:
Deputy Team Leader		Office: Mobile: Private:

Communications Team	
Team Leader	Office: Mobile: Private:
Deputy Team Leader	Office: Mobile: Private:

Figure G: Template to create a list with all team members. Fill in names and telephone numbers in the template and then continue in a similar way with the rest of he teams.

Appendix

Critical Suppliers

- List the critical suppliers you need to contact in a crisis situation. A suitable template is visualized below in Figure H.

Critical Supplier	
Supplier Name:	
Critical Product/Service:	
Street Address:	
City/State/Zip:	
Country:	
Contact Person:	**Phone No. Office:**
Title/Department:	**Mobile No.:**
	FAX No.:
	Other No.:
Alternate Contact:	**Phone No. Office:**
Title/department:	**Mobile No.:**
	FAX No.:
	Other No.:
Responsible for the supplier at your organization:	
Comments:	

Figure H: Template with suitable information regarding contacting critical suppliers

Critical Customers

- List the critical customers you need to contact in a crisis situation. A suitable template is visualized below in Figure I.

Critical Customer	
Customer Name:	
Critical Product/Service:	
Street Address:	
City/State/Zip:	
Country:	
Contact Person:	**Phone No. Office:**
Title/Department:	**Mobile No.:**
	FAX No.:
	Other No.:
Alternate Contact:	**Phone No. Office:**
Title/department:	**Mobile No.:**
	FAX No.:
	Other No.:
Responsible for the supplier at your organization:	
Comments:	

Figure I: Template with suitable information regarding contacting critical customers