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**Packaging systems decision making; to
assure cost efficient transports**

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Industrial Management and Economics with
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Abstract

Purpose – The purpose of this study is to evaluate crucial parameters for decision making of packaging systems in order to assure cost efficient transports. In order to fulfill the purpose, two research questions were formulated.

1. *What parameters are crucial and should be considered regarding one-way packaging and returnable packaging decisions?*
2. *How do the identified parameters interact with each other in terms of decision for a tipping point regarding one-way- and returnable packaging?*

Method – In order to fulfill the purpose and the two research questions, a case study was conducted at Volvo Car Corporation in Gothenburg. The case study was conducted through interviews, document studies and one observation. The collected empirical data was interpreted and analyzed against a theoretical framework and thus generated the study's results.

Findings – The crucial parameters for packaging systems identified are volume, distance, lead-time and collapsibility. Cost is a central parameter and all these four parameters are related to cost. In order to make the optimal choice of what packaging system to use from a decision basis there are interactions among the crucial parameters. The interactions identified in the study are between volume and distance, volume and collapsibility, and lastly between distance and lead-time.

Managerial implications – This study has revealed the importance for a packaging logistician to compare the packaging systems, identify crucial parameters for packaging systems, understand the interactions among the parameters and make decisions regarding packaging systems based on a tipping point. This will help the logisticians to choose the most cost efficient system.

Limitations – The identified parameters are connected to cost in order to develop cost efficient decision basis for packaging systems. This means that cost was the main focus throughout the study. Other focuses, such as environment, quality or ergonomic, could have generated different results.

Keywords – Packaging systems, one-way packaging, returnable packaging, parameters, interactions

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1 Introduction

In this section a brief introduction to packaging is presented. This chapter consists of a problem statement and a purpose sought to answer the research questions. The scope, delimitations and the thesis disposition are thereafter presented in order to illustrate and visualize the structure of the thesis.

1.1 Background

Companies have expanded and established themselves on new markets worldwide due to the effect of increased globalization and competitiveness. This has resulted in the raise of new demands in logistical activities within the supply chain (Schary and Skjøtt-larsen, 2001). It is important to take these logistical aspects into account in order to meet the demands (Brankley, 2003). Packaging is considered as one of the most important activities in the distribution system and supply chains (Chan et al, 2005). Not only does packaging affect every logistical activity, it also has a significant impact on logistics related costs (Hellström, 2007). However, throughout the manufacturing and distribution processes, companies are inattentive towards packaging due to a lack of knowledge of the importance of packaging (Chan et al, 2005). Packaging is often considered as a cost driven activity and rarely recognized as a value-adding component (Chan et al, 2005). Today, almost every product or good needs to be packaged or undergo a packaging process. Even after the immense developments in the sector of packaging, packaging is not getting the consideration it deserves (Hellström, 2007).

There are two kinds of packaging systems (emballage), one-way packaging and returnable packaging (Johansson et al, 1997). One-way packaging and returnable packaging are classified as industrial package (Johansson et al, 1997). Industrial package is an exterior package and is primarily connected to logistics responsibility. The main purpose of industrial package is to protect the goods and simplify the transportation of the goods throughout the supply chain (Gourdin, 2001). This type of packaging is also referred as tertiary packaging (Chan et al., 2005). The two kinds of packaging systems have different features but they are used for the same reasons. Hence, selecting the right packaging system suitable to use for different transportation routes is sometimes challenging (Johansson et al, 1997). A well-functioning packaging system creates benefits for the company (Dominic, 2011).

Attitudes towards industrial packaging have evolved in the sense that more than one parameter has to be considered for packaging (Johansson, 2009). Parameters are measurable factors or characteristic features that helps to define a system and determine its behavior (Howe, 2010). Parameters are often used for judging long-term success by identifying critical points within companies (Howe, 2010). A critical point, also referred to as “tipping point” in this thesis, is an optimum point for a change that represent a critical state of parameters and works as an important position to the success of an operation (Shapiro, 2003). In order to define a tipping point, parameters need to be set and related against each other to find the optimal choice for decision making of packaging (Johansson et al, 1997). It is important to understand the interaction and connection between the different parameters that affect packaging and the packaging systems, one-way packaging and returnable packaging (Dominic, 2011).

One parameter affecting the packaging system is cost. Cost is a key parameter in many companies since it constitutes an essential role in order for a company to be profitable (Hellström, 2007). Cost is recognized as a central parameter since every decision is connected to cost (Alsyouf, 2001). Cost has therefore a central role in impacting all other parameters in order to achieve a profitable decision. A profitable decision is most likely to be achieved by taking cost efficiency into consideration (Alsyouf, 2001). Cost efficiency can be achieved by identifying where the tipping point is located which is considered as the optimum choice (Shapiro, 2003). Cost efficiency is defined as “the degree to which resources have been used economically or in doing the thing right” (Dominic, 2011, s.4). Making the right decision regarding profitability requires an understanding of interaction between different parameters and how they are influenced by cost (Dominic, 2011).

1.2 Problem statement

As described in the background, it is important to understand the interaction and connection between different parameters that affect packaging systems, as well as how the parameters are influenced by cost in order to make the right profitable decisions (Dominic, 2011). Since the onset of globalization, transportation has become more advanced within companies. This creates a need for a better understanding of what packaging systems to use. The increased competitiveness in the business world has also affected the need for a more detailed decision making of how to manage packaging (Dominic, 2011). According to Porter (2001) it is vital to have a detailed decision making for companies that strive to develop in order to be competitive in the market (Dominic, 2011). Decision making is a process whereby companies arrive at a decision. By evaluating different alternatives and their consequences companies can do what they believe has the best outcome (Nitta, 2016).

Today many decisions within packaging are based on company's general basis of what packaging system to use for transport (Finnsgård et al., 2013). This results in inaccurate choices in the long run since the handling of packaging systems does not attain the best profitability and cost efficiency choices (Alsyouf, 2001). Hence, it is crucial to gain a better understanding of parameters that are essential for packaging systems and understand how they are related to each other in a cost efficient manner. Therefore, companies are required to have a more detailed decision making in order to decide upon what packaging system to use worldwide (Dominic, 2011).

There is no specific rule saying that returnable packaging has to be preferred over one-way packaging or vice versa (Johansson et al, 1997). Today, companies have a lack of detailed decision making regarding packaging systems. The area of packaging systems is therefore necessary for companies to look into (Dominic, 2011). In order to decide what packaging system to use it is important to determine the most cost efficient packaging system, which depends on the conditions of each specific case (Johansson et al, 1997). Cost is a central focus point in every decision making regarding parameters for packaging systems. The lack of a profitable decision making within packaging makes it essential to consider the different parameters that are influenced by cost. This is possible by understanding the interaction between the different parameters and defining the tipping point.

1.3 Purpose and research questions

In the problem statement, it is described that in order to achieve cost efficient decisions for transports it is essential to consider different parameters that are influenced by packaging systems, one-way packaging and returnable packaging. The interactions between the parameters are also essential in order to define a tipping point for the packaging systems. Based on this, the following purpose is posed for this thesis:

The purpose of the study is to evaluate crucial parameters for decision making of packaging systems in order to assure cost efficient transports.

To reflect the purpose, two research questions have been developed and are presented below.

The first step in order to achieve the purpose is to identify the parameters that affect the decision regarding one-way packaging and returnable packaging. It is important for companies to identify the parameters since not all of the parameters have the same level of importance for packaging systems. Therefore, the first research question is:

1. What parameters are crucial and should be considered regarding one-way packaging and returnable packaging decisions?

After identifying different parameters it is important to investigate the interaction among the parameters and how they are related to one-way packaging and returnable packaging in order to determine a tipping point for identifying the most optimum decision for packaging systems. This thesis takes the next step, seeking answers by focusing on the following research question:

2. How do the identified parameters interact with each other in terms of decision for a tipping point regarding one-way-and returnable packaging?

In order to answer the research questions, and thus fulfill the purpose, a case study will be conducted at Volvo Car Corporation, Gothenburg.

1.4 Scope and delimitations

Research into packaging is a wide area of study and it is hence necessary to define the scope of this study. The study only includes packaging systems, one-way packaging and returnable packaging. This thesis examines the use of industrial packages and covers the study of packaging systems that are used for transports when the senders and receivers are companies. The customer package, which is for the consumer and what the consumer sees when they buy a product, is not relevant in this thesis and is therefore not addressed. Cost is seen as a central parameter in this thesis.

1.5 Disposition

In order to facilitate ease of reading, figure 1 highlights the content of each chapter of the thesis.

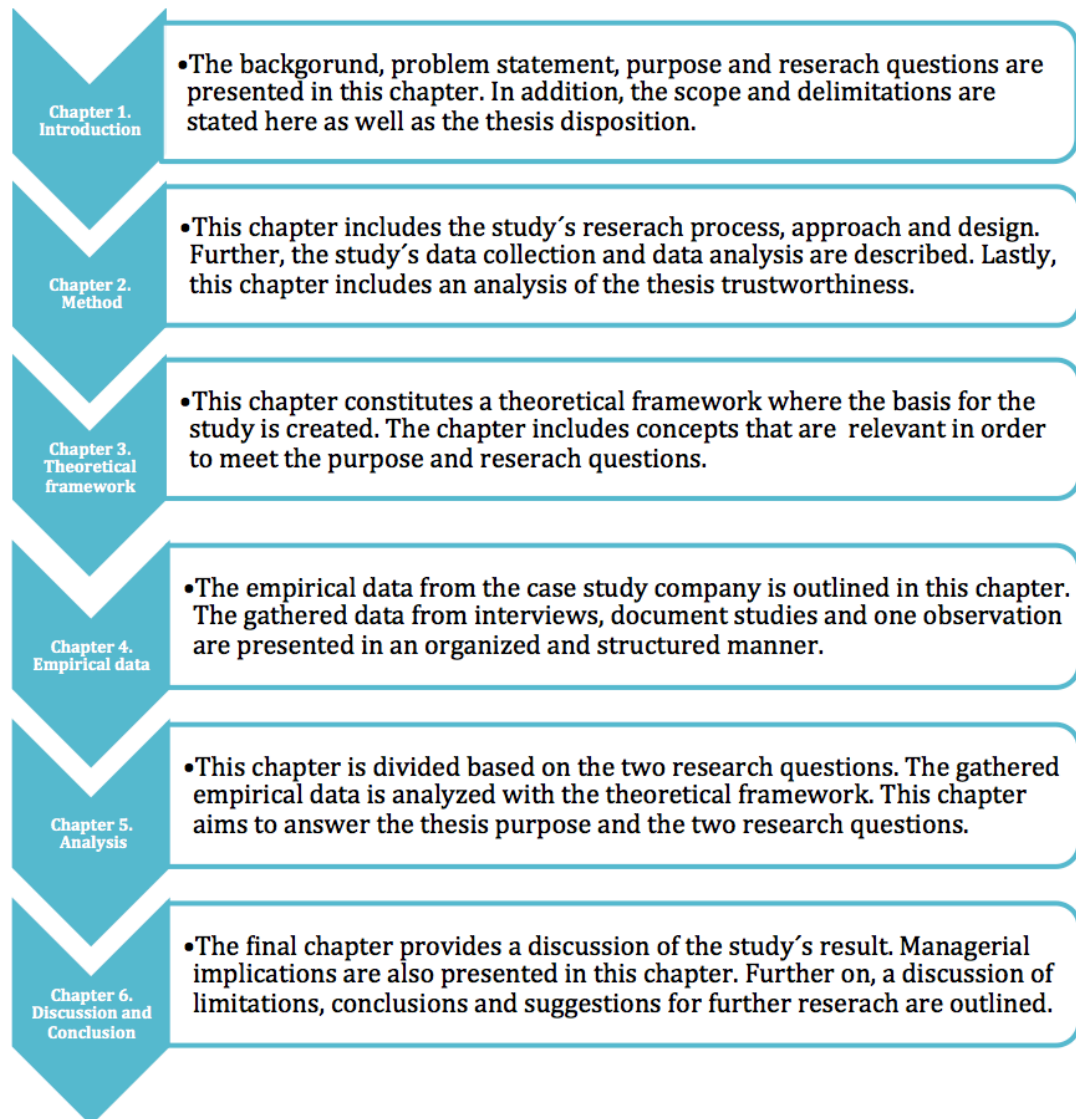


Figure 1. Thesis disposition

2 Method

This chapter gives a brief description of the research process. Thereafter, the study's approach and design are presented. Further, the data collection procedures are described. Methods are outlined with overviews of conducted literature studies, document studies, interviews and observations. Lastly, the trustworthiness of the research process is determined by discussing the reliability and validity.

2.1 Connection between research questions and method

The following section describes methods for data collection and data analysis used to answer the study's research questions. Figure 2 illustrates the connection between the study's research questions and the used methods.

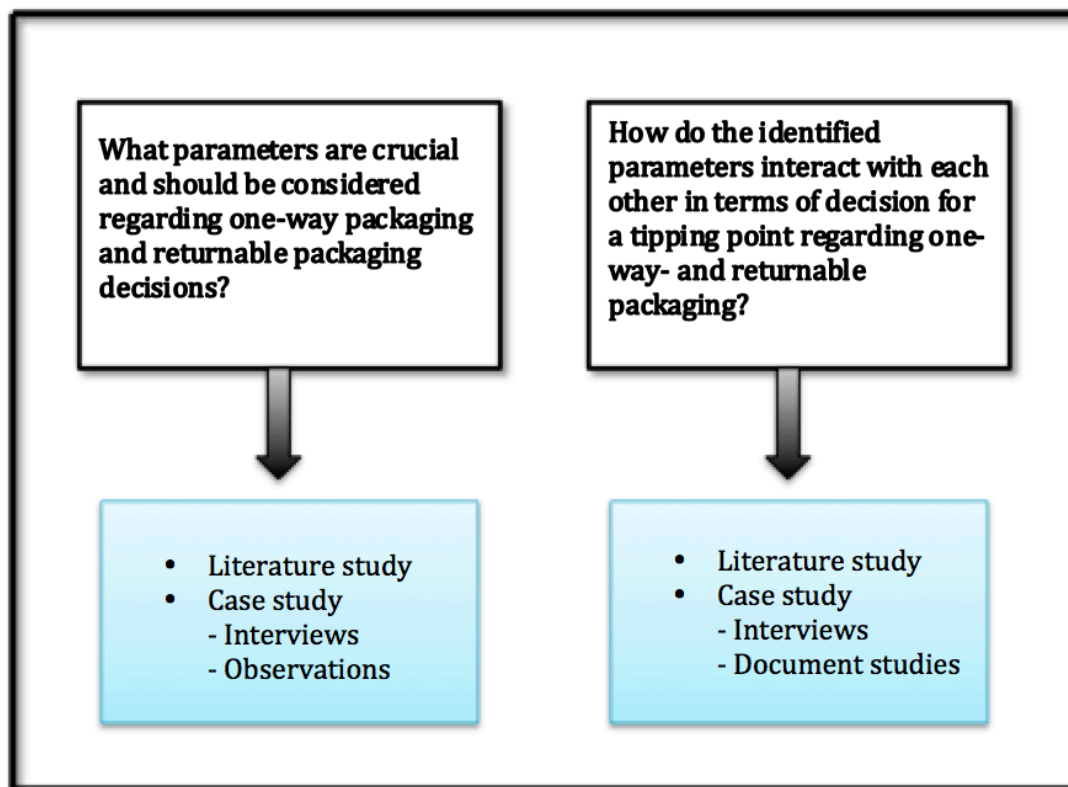


Figure 2. Connection between research questions and method

In order to answer the first research question, a combination of literature study and case studies was conducted. The literature studies provided a theoretical basis for the problem area by gathering knowledge about the different concepts that were necessary for the forthcoming study. The case study involved interviews and observations. The interviews provided understanding of what parameters the company considers for packaging systems, one-way packaging and returnable packaging. The observation was conducted in order to strengthen the interview data.

The second research question was addressed in a similar way as the first research question since it also included theoretical and empirical features. The identified parameters from the first research question were used as a basis to answer the second research question.

The interactions between the parameters regarding cost efficiency could be identified from the concepts that the literature study implicated. The interactions between the

parameters were also influenced by the gathered information from the interviews and the document studies.

2.2 Research process

In order to fulfill the purpose and answer the research questions, the working procedure was divided into five different stages. Figure 3 illustrates the five stages of the working procedure. The stages are the following:

- Pre-study
- Literature study
- Empirical data collection
- Analysis
- Thesis writing

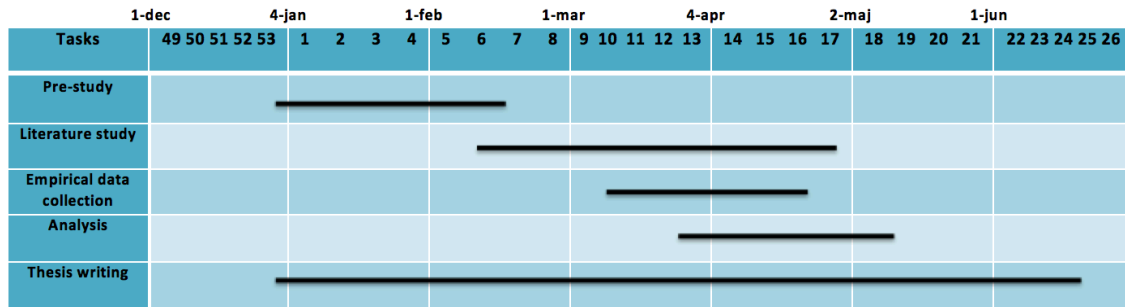


Figure 3. The study's working procedure

The research process started with a visit at the case company, Volvo Car Corporation, where the problem statement was discussed with the supervisors. This resulted in a deeper insight into the company's processes, especially packaging for transports. Thereafter, the process of the formulation of the background and the problem statement created a natural foundation to build the purpose and the research questions on. This resulted in a good basis for the study.

The literature study was conducted to establish a theoretical framework. The literature review started at the start of February and was ongoing till the end of April. Within that time period new relevant concepts were obtained continuously. The theoretical framework is based on previous research about parameters for packaging systems regarding cost efficiency.

The empirical data collection stage started a short time after the literature study since data of relevant parameters were needed from interviews in order to move forward with the study. The observation was conducted to obtain a better comprehension regarding packaging systems. Documents were obtained and analyzed together with the supervisors at Volvo Car Corporation in order to avoid confusion.

The analysis stage took place a short time after that the empirical data collection started. The collected empirical data was analyzed in order to compare the data against the theoretical framework and to compile results and recommendations for further research. The thesis writing was ongoing along all the stages to maintain the focus of the thesis study. For a more detailed schedule of the research process, see appendix 1.

2.3 Approach

The research is based on generating, processing and analyzing the collected information according to a qualitative approach. According to Eriksson and Wiedersheim-Paul (2011) a study of qualitative approach is based on structured data that can be obtained from interviews, observations and document studies. The collected “soft” data is interpreted and analyzed to fulfill the purpose and the research questions of the thesis (Eriksson and Wiedersheim-Paul, 2011). The qualitative approach was needed since the data collection through interviews with people in different positions contributed to a clearer picture of the study's problem area. It is often practical to do ongoing analysis when working with a qualitative study. The advantages of having ongoing analysis is that it can give authors an idea on how to further proceed. New and unexpected information can enrich the study after performing interviews and observations (Patel and Davidson, 2011). However, this research also has features of quantitative methods in terms of the obtained document studies. According to Patel and Davidson (2011) a quantitative approach is the systematic empirical processes of data.

The study's scientific focus is based on a deductive working approach since the study's conclusions are taken from the theoretical framework (Patel and Davidson, 2011). The theoretical framework was used for further data collection in order to create an interview guide as well as conduct the observation and the document studies.

2.4 Design

For this research a case study is conducted at one case company that is a singular case study (Yin, 2007). This research also corresponds to one unit of analysis since the focus was on parameters for packaging systems, instead of several units of analysis, which according to Yin (2007) is a possibility. These designs have been chosen to obtain a deeper research within the chosen area. A singular case study and one analysis implies first level of analysis within a holistic characteristic (Yin, 2007).

The case study was considered as an appropriate approach in order to achieve the thesis purpose and research questions. According to Patel and Davidson (2011) a case study means that it is performed on a delimited group. A group can be defined as an individual, a group of individuals, an organization or a situation (Patel and Davidson, 2011). Within a case study it is common to obtain a holistic view of the present situation through gathering as much information as possible (Patel and Davidson, 2011). In order to get information that is as comprehensive as possible, different collection techniques such as interviews and observations are combined.

The case study was conducted at Volvo Car Corporation (VCC) in Torslanda, Gothenburg. VCC has several global customers, which has resulted in an increased globalization. Today, VCC has a very general basis regarding decisions on packaging systems, one-way and returnable packaging. Due to globalization, it has created a need for a more detailed decision making regarding packaging systems and this suited the purpose of this thesis. The globalization has resulted in increased competitiveness, which requires more profitable and cost efficient decisions on what packaging systems to use. Based on the mentioned conditions, VCC was suitable for this thesis.

2.5 Data collection

The data collection methods included literature studies and collection of empirical data from VCC through interviews, document studies and one observation. The different parts are described in more detail below.

2.5.1 Literature study

To initiate the literature study, information on explaining packaging was collected. The types of literature collected included dissertations, books, and scientific articles. The books were sought from various libraries such as the library at the university of Jönköping, the economic library at the university of Gothenburg and from the city library in Gothenburg. Dissertations regarding the subject area were also found and the references within those dissertations were used for further literature research, so called snowballing. Databases such as Scopus, Primo, Google Scholar, Business Source Premier and SienceDirect were also used to retrieve scientific articles. It was possible to find different articles by using all the databases mentioned. The keywords that were used for the research are illustrated in table 1. The Swedish versions of the keywords were used as well and were used combined in order to achieve a more specific search within the field.

Area	Key words
Packaging	Packaging One-way packaging Returnable packaging Emballage Packaging logistics Disposable packaging Reverse packaging Effective packaging Packaging performance Cost efficiency Packaging systems Packaging decision model Critical point

Table 1. Key words

2.5.2 Interviews

During this study, five interviews were carried out, see table 2. The aim was to obtain a deeper understanding of the packaging systems, one-way packaging and returnable packaging as well as to collect data about the parameters and different cost rates regarding packaging systems. The interviews were carried out in a semi-structured form with some degree of prepared questions, see appendix 2. When the questions are asked in a specific order, but not necessarily, the interview is of a high degree of standardization and this is called semi-structured interviews (Patel and Davidson, 2011).

The funnel technique was used as a basis to construct interview questions. According to Patel and Davidson (2012) the funnel technique contributes with motivation to the person being interviewed. This is because the interview questions start with open questions and ends with more structured questions. The person being interviewed has the chance to verbalize openly at the beginning of the interview process (Patel and

Davidson, 2012). The literature study and the empirical data collection from the observation were the primary sources for interview questions in order to check whether the current conditions and information agrees with the interviews. Whenever new information was obtained from interviews, it was compiled immediately through discussion between the authors and thereafter summarized in a word document. According to Patel and Davidson (2012) it is more difficult to create a real connection to the gathered material as time goes on with the study. If new information that emerged during the interviews were not compiled immediately it could have resulted in forgetting this information and would have been a loss to the gathered material.

The first interview was performed with the senior logistics engineer (C&A) at VCC in Gothenburg. The interview was considered as semi-structured and conducted in order to gather information about relevant parameters for the case company. The second interview contributed to an understanding about the two existence packaging systems, one-way packaging and returnable packaging. Further, the third interview was conducted in order to collect information about and understand different cost rates of the case company's packaging systems. The fourth interview was carried out in order to fill out the unclear gaps of information about repacking that were difficult to obtain during observation. Lastly another cost rate interview was carried out with a new interview person in order to confirm the previously gathered cost rates, this increased the credibility of the previous data.

Table 2 Conducted interviews

Date	Purpose (What)	Role	Method (How)	Time
2016-03-21	Parameters	Senior logistics engineer (C&A)	Semi-structured	1h
2016-03-22	Packaging systems	Graduate/inbound logistics and Packaging engineering Packaging developer	Semi-structured	1h
2016-03-22	Packaging cost rates	Inventory planner	Semi-structured	1h
2016-03-24	Repacking	Packaging developer	Semi-structured	1h
2016-03-24	Packaging cost rates	Packaging engineering	Semi-structured	1h

2.5.3 Observations

One observation was carried out in repacking. The observation was conducted to observe how the repacking activities are carried out for the different packaging systems. This resulted in a basic understanding about repacking that would be

beneficial for the repacking interview subsequently. Notes were taken at the observation to ensure that all information was registered.

Empirical data collections are useful to carry out in a natural context and this is feasible through observations (Patel & Davidson, 2012). By gathering information through observations, it enabled the authors to come up with new ideas on how to proceed with further studies. The conducted observation was performed in an unstructured form since it was used to obtain as much data as possible within the problem area (Patel and Davidson, 2011). The gathered material from the observation was used continuously throughout the research process in order to create and retain a deeper understanding for the document studies and interviews. The observation is presented in table 3.

Table 3 Conducted observations

Date	Purpose (What)	Method (How)	Time
2016-03-24	Repacking	Unstructured	2h

2.5.4 Document studies

During the study three document studies were obtained from the case company, see table 4. The documents obtained, gave a better understanding of the current packaging systems and parameters. The document studies main purpose is to strengthen the collected data from other empirical data and sources (Yin, 2007). It is important to identify when and why the studies were obtained. The author and his knowledge in the field can determine how reliable the information is (Patel and Davidson, 2011).

The obtained documents from VCC consisted of a packaging catalogue, cost rates data and current emballage rates. The packaging catalogue consists of information about packaging systems, one-way packaging and returnable packaging. The excel file of cost rates provides data of cost for returnable packaging transports within the company. The standard catalogue provided rates for different parts of the emballage, one-way- and returnable emballage.

Table 4 Conducted document studies

Date	Purpose (What)
2016-02-23	Packaging catalogue
2016-02-23	Excel file of cost rates
2016-03-24	Standard catalogue for emballage rates

2.6 Data analysis

The gathered empirical data from the case study and the literature study created a foundation for the thesis. A theoretical framework was compiled by processing the concepts regarding packaging. The empirical data was thereafter analyzed and compared with the theoretical framework. Packaging was analyzed from the concepts that were compiled from the theoretical framework. The data collection and the analysis were conducted based on literature studies and the theoretical framework. According to Yin (2007) this is called “Pattern matching”.

Literature studies have generated the theoretical framework while the case study has generated the empirical data through interviews, document studies and one observation. Figure 4 shows how the data collection and the analysis were conducted through literature studies and the case study. Data analysis was conducted with reference to the empirical data and theoretical framework, which entailed a result.

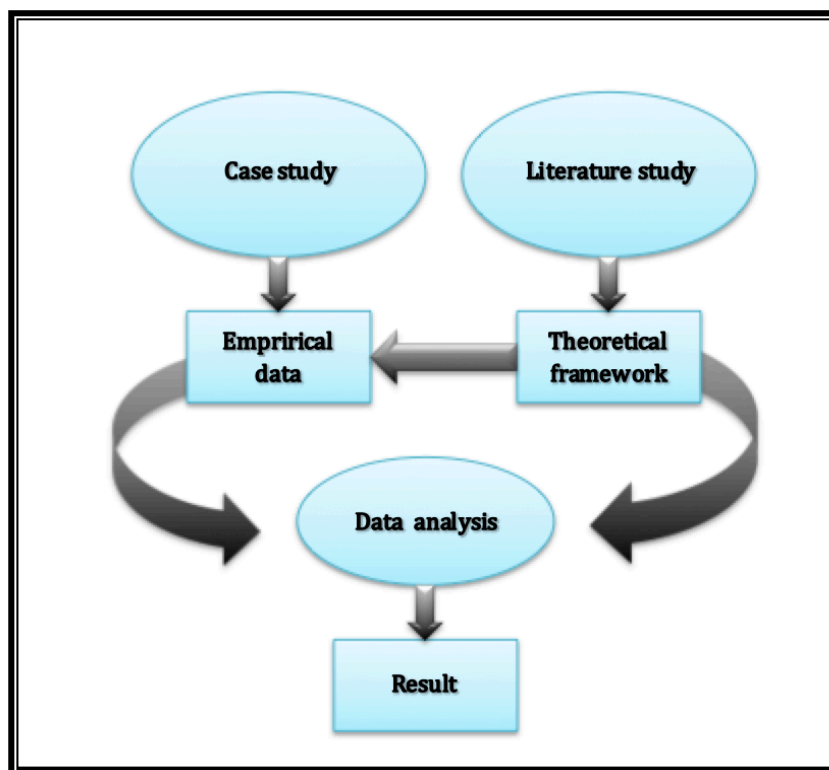


Figure 4. The study's data analysis

2.7 Trustworthiness

In order for the study to achieve reliable and sustainable results, evaluations of reliability and validity were conducted throughout the study. The reliability is all about minimizing the number of errors (Yin, 2007). This can be achieved by using different procedures to document as properly as possible. It is important for the authors to conduct an interview with profound knowledge of the issue being studied (Yin, 2007). This was obtained by being prepared on literature research before the interviews took place. The interviews were documented by both authors to see if the interview answers yield the same comprehension. The interview answers were thereafter discussed between both authors, analyzed and documented after the interviews ended. In order to simplify the analysis and the discussions of answers the authors recorded the interviews. This technique was used in order to minimize the

risks of losing important information. Hence, this results in achieving higher reliability (Patel & Davidson, 2012). Triangulation was used for configuration of data – in other words, various methods were used for data collection such as interviews, observations and document studies. The use of multiple methods is aimed at ensuring high reliability through results and conclusions that are based on different sources (Yin, 2007).

Reliability and validity are related to each other, which means that it is not possible to just prioritize one of them and exclude the other. Good reliability is a requirement in order to have good validity (Patel & Davidson, 2012). Validity can be defined as measuring instruments ability to measure what one intends to measure. There are two different types of validity, internal and external. The internal validity refers to whether the result is consistent with the reality but also if what is said to be measured is actually measured (Merriam, 2010). The extent to which the results of a study can be generalized beyond the current case study is called external validity (Merriam, 2010). The problem area regarding packaging systems can be applied on other companies. The study was conducted at Volvo Car Corporation with a result that is expected to be applicable within similar businesses because of the general approach the study comprises. Therefore, the study achieves external validity. The internal validity was ensured through a working procedure. The purpose and research questions were formulated in regards to the background and the problem statement. This created a better understanding of what is being studied. Thereby, the approach could be determined for how to answer the research questions. Hence, this is considered to contribute to high validity. The high validity has also been achieved by “Pattern matching”. According to Yin (2007), it is a good technique to achieve good validity.

3 Theoretical framework

This chapter gives a theoretical basis and selected concepts are presented in order to answer the study's research questions.

3.1 Connection between the research questions and the theory

In this chapter, concepts are presented in order to answer the study's research questions. Figure 5 illustrates the connection between the study's research questions and the used concepts in order to answer the study's two research questions.

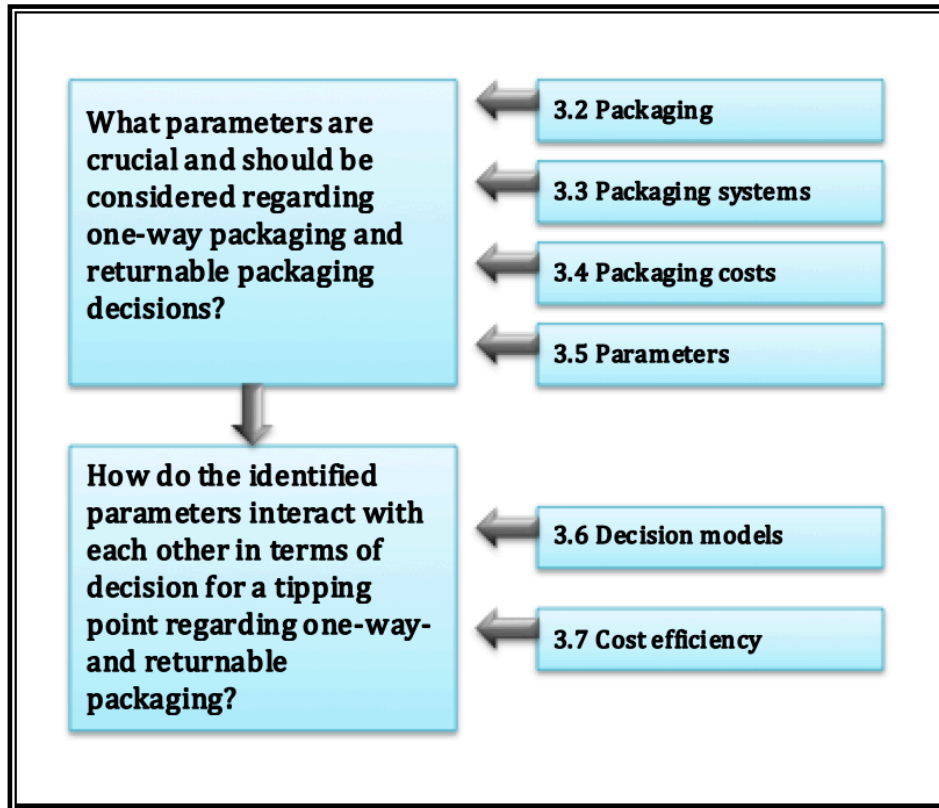


Figure 5. Connection between the research questions and the frame of reference

In order to give a theoretical basis for the first research question the following concepts are needed in the theoretical framework: packaging, packaging systems, packaging costs and parameters. Packaging is described and defined in order to understand the meaning of packaging. The classification of packaging is also mentioned in this section. Packaging systems need to be described in order to understand the connection between packaging and the packaging systems. Under the third section, packaging costs, four areas of packaging are described in order to understand what kind of contribution the areas have on packaging costs. There is a need to understand different parameters that affect packaging systems in order to identify what packaging system is the most appropriate to use.

In order to answer the second research question there is a need for concepts from the first research questions as well as a theoretical basis about: decision models and cost efficiency. Describing a decision model is relevant as it aids understanding of what

the tipping point is and how to identify the optimal choice within packaging systems. Cost efficiency is an important concept to understand in order to make decisions on packaging systems in a cost efficient manner. The last section includes a summary of the overall concepts described in order to clarify the connections of the different concept sections.

3.2 Packaging

There are six main functions for packaging: containment, protection, apportionment, unitization, convenience and communication of the product (Finnsgård et al., 2013). The definition of packaging is comprised of three following statements (Hellström, 2007, p. 3):

1. “Packaging is a coordinated system of preparing goods for transport, distribution, storage, retailing, and use”
2. “Packaging is the means of ensuring safe delivery to the ultimate consumer in sound condition at minimum cost”
3. “Packaging is a techno-economic function aimed at minimizing costs of delivery while maximizing sales (and hence profits)”

Packaging can be classified as primary, secondary or tertiary (Hellström, 2007). The primary packaging is used for consumer package and the secondary packaging is used for outer/retail packaging. Tertiary packaging is used for transportation package. (Chan et al., 2005). This is also referred to as industrial packaging.

3.3 Packaging systems

During transportation of packages there are two kinds of packaging systems that can be used, either one-way packaging or returnable packaging. The economic criterion is one of the most important criteria in the evaluation of what packaging system to use (Finnsgård, 2013). There is a need for systematic methods in order to evaluate a packaging system and its impact on the supply chain (Finnsgård, 2013).

3.3.1 One-way packaging

One-way packaging is used during transports from a sender to a receiver. Cardboard boxes are mainly used for one-way packaging since it can only be used once. One-way packaging can also be made out of wood, in some cases even plastic. The biggest impact of one-way packaging is that it causes excess waste (Dominic et al., 2000). Figure 6 illustrates an example of one-way packaging.



Figure 6. Example of one-way packaging (Kaizen Emballage AB, 2016)

3.3.2 Returnable packaging

Returnable packaging system is a system that can be utilized a certain number of times before it is disposed. There are various types of returnable packaging, such as pallets, returnable containers or slip-sheets (Kroon and Vrijens, 1995). The most common material that returnable packaging are made out of is plastic, wood or metal (Dominic et al., 2000). Figure 7 illustrates an example of returnable packaging.



Figure 7. Example of returnable packaging (Thryft, A.R, 2012)

3.4 Packaging costs

There are various costs that packaging affects (Dominic, 2011). However, the main costs that packaging affects are transportation, waste, handling and quality (product protection), all these costs will be presented in this section (Dominic et al., 2000).

3.4.1 Transportation

The costs associated with the transportation depend on various factors. Especially on how good the packaging is packed and how good the space is used in the trailer while transporting the packages to different locations (Dominic et al., 2000). It is important to use the volume of the trailer fully in order to minimize the transportation costs. Therefore, it becomes necessary that packages should be stacked vertically on each other. This is an important aspect for both one-way packaging and returnable packaging (Dominic et al., 2000). Since one-way packages often are more weight/volume efficient than returnable packages, the load factor will be higher with one-way packaging if the packages can be stacked on each other. The returnable packaging is heavier and more robust as it is built to withstand more usage (Dominic et al., 2000). However, load factor is lower in one-way packaging if the packages could not be stacked vertically. If the aim is to reduce the packaging costs, volume and weight efficiency are two vital aspects that need to be taken into account. Volume efficiency is about how well the space is used throughout the supply chain and can be defined as the utilization of volume. Utilization of the container in reduction with product weight is defined as weight efficiency (Dominic et al., 2000). The packaging should weigh as little as possible, which is a general requirement of packaging. There are consequences in low volume and weight efficiency. The consequences are especially increased transport costs, handling costs and warehousing costs (Dominic et al., 2000). Moreover, return transport costs are highly influenced by the transport distance, possibility of taking advantage of imbalance in transport flow and whether packaging is collapsible (Dominic et al., 2000).

3.4.2 Handling

Repacking the goods is one of the largest parts of the costs that occur from handling. There are different reasons for repacking. Goods that arrive in one-way packaging are

moved to a repacking area where they are repacked into more suitable packaging so that they are easier to handle in production. Packages that arrive damaged are also in need of repacking before being used in production. By using some sort of durable packaging in production will reduce the handling time and therefore will be beneficial to the company (Chan et al., 2005).

After the delivery of a trailer to its destination, manual labor is required to unload packages from trailers (Dominic, 2011). This manual labor is an additional cost that a company has to bear. This cost has to be considered while deciding between one-way packaging and returnable packaging because the packaging systems generate different costs (Dominic, 2011).

3.4.3 Quality (Product Protection)

Degree of protection is directly proportional to the cost of packaging (Gourdin, 2001). Hence, packaging gets more expensive with the protection of packaging. Figure 8 plots packaging expense versus damage and from this plot it can be concluded that chances of damaged goods raises when a little amount of funds are spared on packaging (Gourdin, 2001).

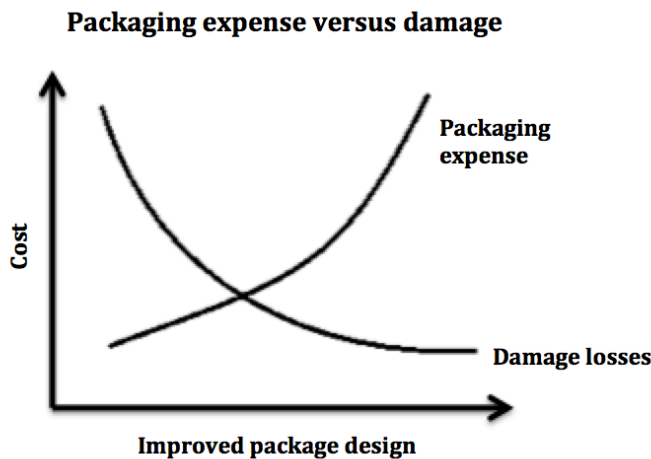


Figure 8. Trade-off between packaging expenses and damage (Model based on Gourdin, 2001, p.156)

Packaging costs and transportation costs are also related to each other as displayed in the following figure:

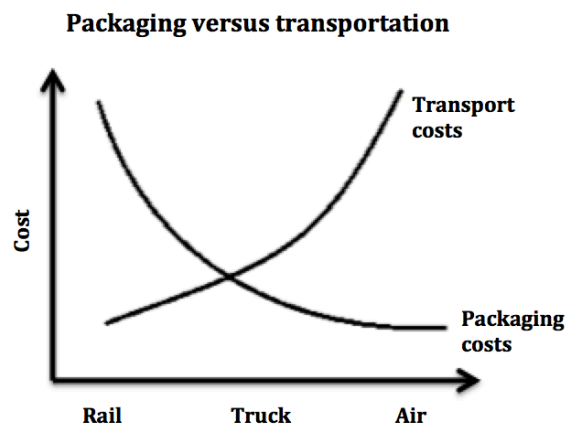


Figure 9. Trade-off between packaging costs and transportation costs (Model based on Gourdin, 2001, p.156)

Chances of goods getting damaged are higher in the rail and road form of transports (Lumsden, 2006). Therefore, in order to keep the levels of damaged goods to a considerate level, more amounts of resources are spent on the packaging of goods, which are to be transported, by rail or road. Border-crossing transports is the type of transport, which has the highest amount of damaged goods. In this kind of transports, transport damages reach up to three times more than a regional or national transport (Lumsden, 2006).

Products that are moved manually, for example in warehouses, are generally handled with less care than an automatic method or process and due to this reason chances of products getting damaged are higher if goods are handled manually (Gourdin, 2001). Therefore, more amounts of resources need to be spent on goods when handled manually and not with automatic methods or processes (Gourdin, 2001). Figure 10 displays a plot of packaging versus materials handling/warehousing in relation to costs of packaging.

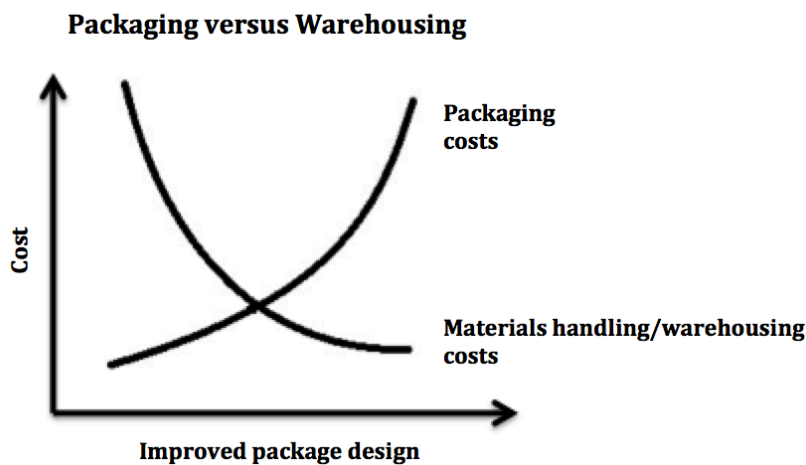


Figure 10. Trade-off between packaging costs and materials handling/warehousing costs (Model based on Gourdin, 2001, p.136)

From the previous three figures 8, 9 and 10 it can be established that it is difficult to estimate the level of protection the packaging should provide and this estimation is important in order to make sure that packaging is not made too weak or too strong (Lumsden, 2006). Use of lot of materials in the process of packaging leads not only to higher packaging costs but also higher distribution costs. In contrast to this, if the packaging fails to provide a required level of protection the company has to bear very high expenses because of the damage to the goods resulting from the packaged goods not having required level of protection (Lumsden, 2006). Somewhere in between these two facts there actually lies a breakeven point or a minimum level of protection, which is hard to identify. Minimum state is the most economically efficient state and this state occurs when the overall cost is as low as possible (Lumsden, 2006).

3.4.4 Waste

Waste is another cost that a company has to bear. Hence, the waste can be seen as out-of-sight resource for the company and analyzing the waste can prove to be economically rewarding (Nyström, 2006). It is a waste to just throw away as garbage, the things once purchased and used during transportation to different locations (Nyström, 2006). There will be cost savings for the company if they manage to trim down the waste, for example minimizing the one-way packaging. This can result in

cost savings in two parts for the company, purchasing and disposal (Nyström, 2006). Hence, it is a cost for the disposal service (Nyström, 2006).

3.5 Parameters

There are a number of parameters that need to be considered in order to decide what packaging system to use; whether one-way or returnable packaging (Dominic et al., 2000). The transport distance and season variation are two of the extremely crucial parameters that need to be taken into account when analyzing what packaging system to use (Dominic et al., 2000), see figure 11.

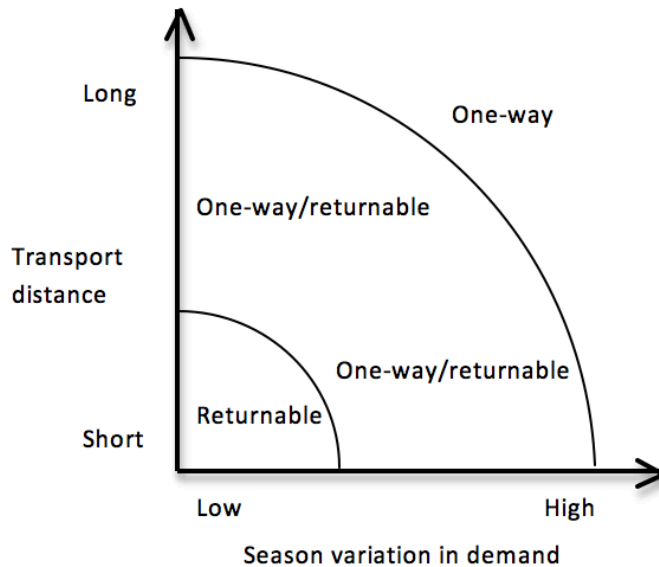


Figure 11. Transport distance and Season variation (Dominic et al., 2000, p. 102)

In a case where the transport distance is long and season variation is high, one-way packaging stands to be the most appropriate packaging system as cost for the return of empty trailer or any transport container would be very high (Dominic et al., 2000).

Besides the transport distance and season variation there are other parameters that need to be taken into account when analyzing what system is the most appropriate (Dominic et al., 2000). The parameters that need to be considered are the tied up capital, return handling, economic loss of packaging, environment and ergonomics (Dominic et al., 2000).

Tied up capital is influenced by the packaging turnover rate and the total number of packages in the system will be less with a fast turnover rate. Smaller amount of packages will reduce tied up capital and warehousing cost, due to the less space requirements (Pewe et al., 2002).

Return handling has an effect on the economical result (Garcia-Arcia and Prado-Prado, 2014). There are certain parameters, which are the part of return handling. Collapsibility is one parameter, returnable packaging being collapsible is an advantage to the packaging system as the room needed for storage and handling will be less (Dominic et al., 2000). Another parameter is the stages in return handling, the system will be more economically beneficial if the numbers of steps is kept as low as possible. Even the cleaning of returnable packaging is an essential cost in return handling (Kroon and Vrijens, 1995).

Economic loss of packaging, every package has a specific life span. Economic loss of packaging is used to figure out number of times a packaging can be used more than its actual life span. Significantly, this can be a big impact on the economical result for the returnable system since it is more expensive than a one-way system (Dominic et al., 2000).

Environment is important to minimize packaging waste and to emphasize more on responsible handling of packaging materials. A way to reduce the emissions caused by packaging is the reusing of products and recycling (Kroon and Vrijens, 1995). One factor that is important to consider is the resource efficiency, which concerns decrease of the amount of material required to manufacture the packaging (Garcia-Arcia and Prado-Prado, 2014). Even the amount of dangerous substances should be minimal. Also, recycling should minimize waste and returnable packaging should be used when it is possible (Garcia-Arcia and Prado-Prado, 2014).

It is important that the packaging is ergonomic (Garcia-Arcia and Prado-Prado, 2014). Returnable packages contribute more ergonomic benefits, as these packages are easier to handle, which allows for a better workflow compared to one-way packaging (Dominic et al., 2000).

3.6 Decision models

There is an increase in the importance of using the most efficient decision-making model in order to ensure the optimum performance in organizational systems at any time (Alsyouf, 2001).

The decision model can be referred to as critical point model. This is because critical point is being identified and analyzed through a decision model. The decision model contributes with place for discussion and dialogues about the parameters that address the decision model (Sharipo, 2003). Usually the parameters interact with each other in order to define a tipping point within the model (Slack and Lewis, 2011).

3.6.1 Critical point/tipping point

Critical point is an important concept to use when planning for a new change within the company (Slack and Lewis, 2011). A critical point model usually includes two components, or parameters (Ax et al., 2011). To identify the critical point, the two components have to interact with each other in order to calculate where and how they are best used for the most optimum choice (Ax et al., 2011).

A critical point model, or decision model, does not work as a decision making technique that give the “right” answer, but it provides a focus for discussion and dialogue (Sharipo, 2003). The critical point works as a more robust strategy in order to lead the company to better choices (Sharipo, 2003). The critical point model is also focusing heavily on system thinking. System thinking is a method for seeing how parts fit together (Sharipo, 2003). This system helps us see the interconnection of the systems components or parameters and how the behavior of a system results from the interconnection of its components (Sharipo, 2003).

Figure 12 is an example of an illustrated critical point: We assume that the parameters in this case are volume and revenue (sek). A critical point would indicate the volume point and the revenue point for costs to be zero (Ax et al., 2011). That point has to be a mutual point for both of the components. Volume and revenue that exceeds the

critical point, a profit is exhibited and for volume and revenue that falls below the critical point, the cost is higher than the income (Ax et al., 2011). See figure 12.

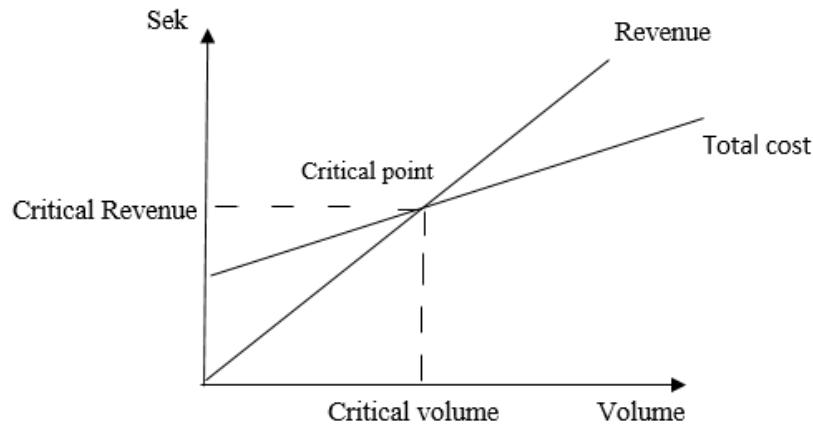


Figure 12. Example of a critical point model (Model based on Ax et al., 2011, p. 81)

3.7 Cost efficiency

Cost efficiency is about maintaining efficiency in economic benefits, which influences the productivity, competitiveness and profitability processes in manufacturing organizations (Alsyouf, 2001). Business in general is influenced by the use of cost efficient approaches, in particular in how to maintain the cost efficiency (Alsyouf, 2001). The survival of any business depends mainly on its ability to compete on cost effectively. The main purpose of a cost efficient approach is to improve the long-term profitability, which is influenced by the result in productivity advantage. Productivity is reached by high efficiency such as lower cost and value advantages (Alsyouf, 2001).

Cost is a central topic in almost every decision making in an organization. If the decision or change is not in the cost range then it creates a problem (Alsyouf, 2001). Today, many organizations ideally would like to improve and grow globally while still maintaining high level of cost efficiency or even higher cost efficiency (Slack and Lewis, 2011). Logically, when organizations grow it will reduce the organization's ability to operate cost efficiently. Conversely, in order to improve cost efficiency there has to be some limits to their developments (Slack and Lewis, 2011). Christopher (1998) illustrates that success depends on having either a cost advantage or a value advantage in the amount of growth in any competitive context (Alsyouf, 2001).

3.8 Summary

In this section, a summary of the described concepts is presented in a model, see figure 13. As described previously in section 3.4, there are a number of costs related to packaging costs. The mentioned packaging costs are waste, handling, transportation and quality (product protection). These four costs are connected to packaging systems, one-way packaging and returnable packaging. Further, there are several parameters also connected to packaging systems. As mentioned previously in section 3.5, the parameters are distance, season variation, tied up capital, return handling, economic loss of packaging, environment and ergonomics. Cost is the central parameter and all parameters are related to cost.

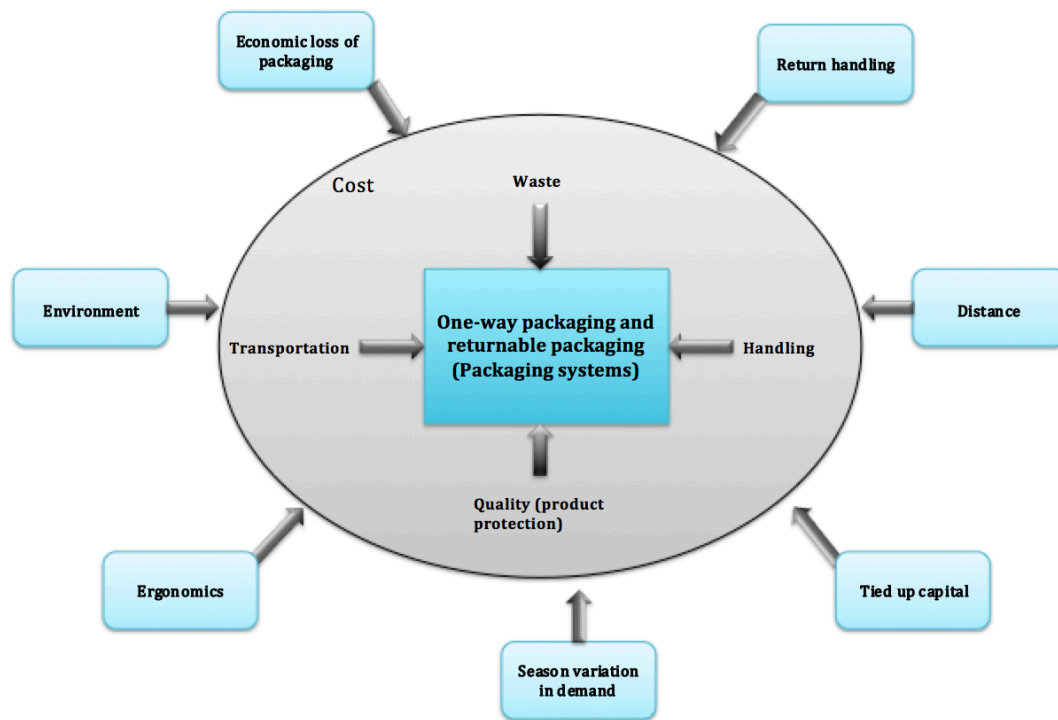


Figure 13. A summarizing model of the theoretical framework

4 Empirical data

This chapter provides a description of the company within the case study object. Further on, the conducted empirical data is described in order to provide answers for the research questions.

4.1 Company description

The empirical data was collected from the case company, VCC. VCC is a global company that has many internal and external delivery processes. These processes occur both to and from the company. In other words, VCC has internal and external delivery processes both for inflows from the suppliers and outflows to the customers, see figure 14. The internal delivery processes are between VCC's own production plants located worldwide. The external delivery processes are between VCC and other suppliers located worldwide. Products that are transported internally and externally are mostly products that are ready to go into the production line directly such as tires, brake discs and rods. The product parts can also be used as spare parts to repair damaged cars.

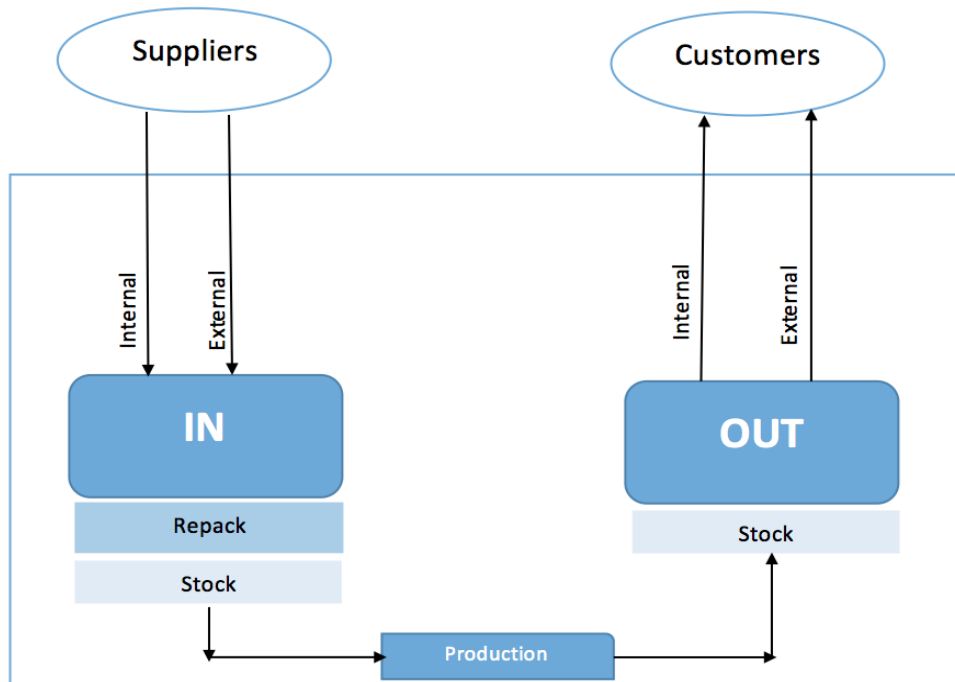


Figure 14. VCC's internal and external delivery processes

VCC is a global company, which continuously strives to make progress in order to keep their position in the market. Therefore, transportations become very important for VCC. VCC's focus is to increase the use of returnable packaging during transports to their customers in Europe. VCC has a relatively new packaging logistics department in their organization. The packaging department began to operate in 2014 due to the separation from Volvo AB. This resulted in that VCC had to set off a new packaging department for their transports to their global customers.

VCC uses different packaging systems during their transports. The packaging systems that VCC uses are one-way packaging and returnable packaging. Within one-way packaging there are standard emballage that VCC wants their suppliers to use during transports to their company. There is also an emballage called heavy duty within one-

way packaging that is used for special parts such as engines and windshields since they are sensitive to transport. Within returnable packaging there are standard emballage and special emballage. The special emballage is equivalent to the heavy-duty emballage. Standard emballage for both one-way packaging and returnable packaging represents the majority use of transports and the focus throughout the study is therefore based on the standard emballage, see table 5.

Emballage	
One-way	Returnable
• Standard	• Standard
• Heavy-duty	• Special

Table 5. VCC's different packaging systems

4.2 One-way packaging

One-way packaging is a packaging system that is used during transports from a sender to a receiver. The one-way packaging is disposed after being used once during transports since the material of the one-way emballage is made out of cardboard. The most common one-way packaging that VCC uses is the standard emballage. The one-way packaging can only handle one transport from a sender to a receiver before being discarded. VCC often uses one-way packaging for long distances and/or when receiving spontaneous orders from their customers. In this case customer order needs to be transported as fast as possible. The packaging engineer and developer say that, "Standard one-way emballage is the most appropriate and cost efficient emballage to use during these situations". There is also an ease of planning the transports of standard one-way emballage compared to returnable emballage. The standard emballage are ordered from an external company called Papyrus. The emballage from Papyrus are made out of cardboard boxes. Papyrus has standard emballage that consists of the right measurements and volumes for VCC when the packages arrive into the company. The standard emballage are therefore used in VCC's production line without the need for many adjustments. Standard emballage can also be ordered from other external companies with other measurements that need more adjustments before being placed into the production line. A standard one-way emballage does not only consist of the package (box) itself but also a pallet, lid and minimum four frames that the one-way box is placed into.

Standard one-way emballage are not as robust as returnable emballage even though one-way emballage have frames, lid and a pallet. This because the one-way emballage are loose within the frames and can move around during the transports. The cardboard boxes can therefore get damaged during transports. Many standard emballage that VCC uses are often damaged when the packages pass through many borders during transports to their global customers. The reason for damaged emballage is plenty of loading and unloading activities that occur when the emballage passes the borders. The quality of the cardboard boxes needs to be managed carefully in order for them not to be damaged.

4.3 Returnable packaging

The returnable packaging is the most used packaging system at VCC. The returnable system is mostly used within Europe. Returnable packaging is reusable and creates more savings for VCC in the long run due to the hard material the returnable boxes

are made out of, such as plastic and wood. Returnable packaging system is more sustainable due to the reusability. The standard returnable emballage, which is the most used returnable emballage within VCC, consists of the box itself, a pallet, lid and minimum four frames.

A problem that occurs regarding returnable emballage at VCC is the errors in emballage inventory count. This is due to the loss of emballage during transports to their global customers. VCC has experienced many cases of stolen and/or disappeared emballage during the return transports. VCC's customers are responsible for the return transports of the emballage but still 2 percent of returnable emballage goes missing every year. The reason for the 2 percentage of missing returnable emballage is still unknown. In order to prevent this problem VCC plans to establish a new rule, where their customers will be fined a sum corresponding to the amount of missing emballage.

4.4 Repacking

According to the packaging developer "Repacking is considered as a very important activity for packaging systems at VCC". The amount of repacking is different for the packaging systems depending on the emballage. One-way emballage requires more repacking than returnable emballage. All one-way emballage does not arrive to VCC from the suppliers in the right measurements and is therefore not placed into the production line directly. One-way emballage mostly requires repacking before being placed into the production line in order to achieve the criteria of the right measurements. The one-way emballage are replaced into approved emballage that can be placed into the production line and the one-way emballage are thereafter disposed. Returnable emballage does not require as much repacking as one-way emballage when they arrive to VCC since they already have the right criteria for being placed into the production line. However, there are exceptions for repacking for returnable emballage as well. If the returnable emballage arrives damaged from the supplier the emballage needs to be repacked before being placed into the production line. Emballage are unloaded from the trucks when they arrive at VCC's cross stock. The emballage are then placed on the repacking station if there is a need for it and if not the emballage are directly placed into the storage. After the repacking station the emballage are stored before being placed into the production line. The cost and time for repacking can be reduced at VCC if the global customer orders are one-way emballage from Papyrus since it does not require many adjustments before being placed into the production line.

4.5 Packaging costs

There are different costs for both one-way packaging and returnable packaging. The cost of a one-way emballage (box, a pallet, lid and four frames) is cheaper than the cost of a returnable emballage. The total cost for a one-way emballage is approximately SEK 370. There is also an additional repacking cost for one-way packaging of SEK 200/emballage. For the returnable packaging there is an investment cost where the cost of the returnable emballage is included and is approximately SEK 400. The investment cost is based on 5 years with an interest rate of 13 percentages. There are also additional costs for the returnable packaging such as the cost for the return transport and a maintenance cost. The maintenance cost occurs from cleaning due to the stickers and staples that are put onto the emballage. These stickers and staples are cleaned manually from the emballage before they can be reused.

Further, there are different costs depending on what volume is being transported for the packaging systems. The higher volume to transport the less cost per volume unit. There is therefore a benefit in sending a full trailer. Table 6 illustrates the decrease of cost when the volume is higher for one specific country.

Volume (m ³)	Cost (Euro/m ³)
Average of <= 1m ³	67,6
Average of <= 5m ³	41,4
Average of <= 10m ³	33,0
Average of <= 20m ³	28,3
Average of <= 30m ³	26,3
Average of <= 40m ³	24,6
Average of <= 50m ³	24,6
Average of <= 60m ³	23,5
Average of <= 70m ³	22,1
Average of <= 80m ³	21,1
Average of <= 90m ³	19,0
Average of > 90m ³	17,6

Table 6. Volume and cost for transports to one specific country (Volvo Car Corporation, 2016a)

4.6 Parameters

VCC seeks to reduce costs for packaging systems, which means that VCC strives for lower costs in their activities. The goal is to reduce the cost continuously. All parameters are driven by cost and the most relevant parameters for packaging systems at VCC are distance and volume. Since VCC has many internal and external delivery processes the distance of the transports to their customers are significant. The distance becomes important to observe in order to gain efficient transports at all times. The volume of the transports is critical and is also an important parameter for VCC to consider since the cost for different volumes varies to their global customers. The volume is therefore important to identify since decisions regarding how much to transport and to what distances are crucial to understand in order to know what packaging system to use.

Lead-time, unit load and collapsibility are other parameters that are relevant for packaging systems. Lead-time is relevant to consider since it ties up the emballage from the time that the emballage leaves VCC for transports to customers until the emballage have arrived back at VCC. The lead-time has to be considered in order to know the amount of tied up emballage in transports and due to this the amount to invest in emballage can be decided. Unit load is also an important parameter for VCC since it is necessary to know how many parts an emballage can contain. Most of the returnable emballage are collapsible. This works as an advantage for the returnable transports since the proportion of the collapsibility for the emballage creates cost savings. VCC uses a collapsibility of 1/10 for their emballage.

There are interactions among the five mentioned parameters, see figure 15. Lead-time interacts with distance since it is dependent on distance. Unit load and collapsibility interacts with volume since both parameters constitutes a volume in a trailer. Since distance and volume are two of the crucial parameters they constitute the biggest interaction, see the thicker arrow in figure 16, even though all parameters are equally important. Since cost is considered as a central parameter at VCC, all parameters are linked to cost.

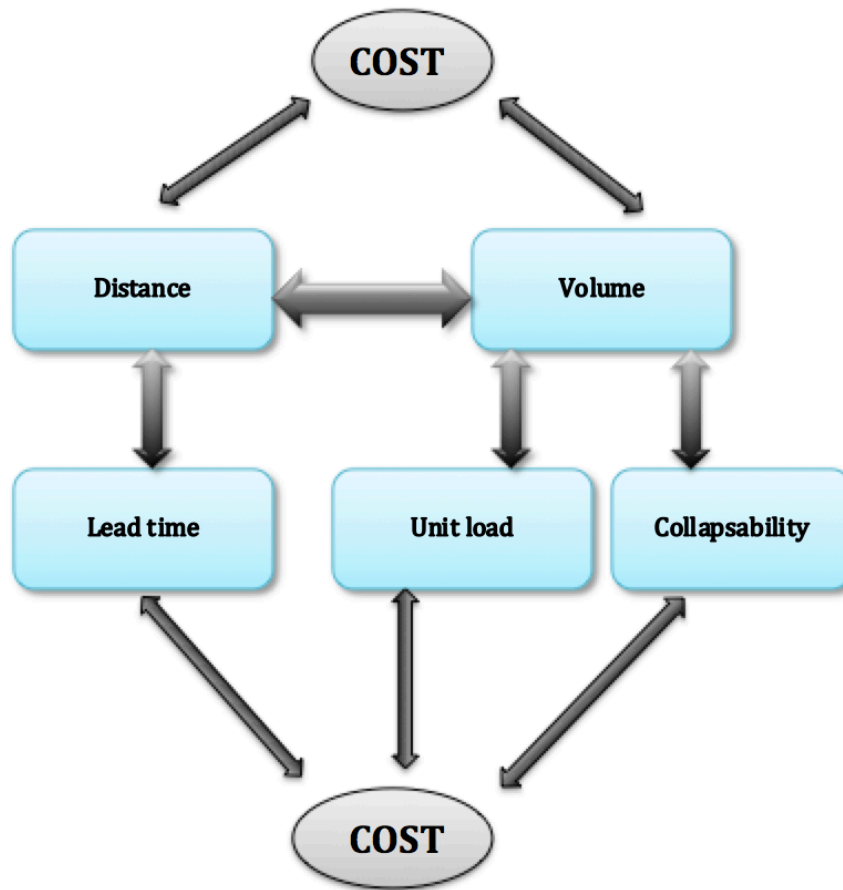


Figure 15. The interactions among the parameters

4.7 Summary

In this section a summary of the empirical data is presented, see figure 16. VCC has different costs for packaging systems, one-way packaging and returnable packaging. The costs are emballage, investment, repacking and maintenance as mentioned previously in section 4.5. The parameters outside the cost circle consist of VCC's most important parameters for packaging systems. These parameters are volume, distance, lead-time, collapsibility and unit load as mentioned previously in section 4.6. VCC uses the mentioned parameters in a cost efficient way since cost is the main parameter for VCC to consider for every decision making.

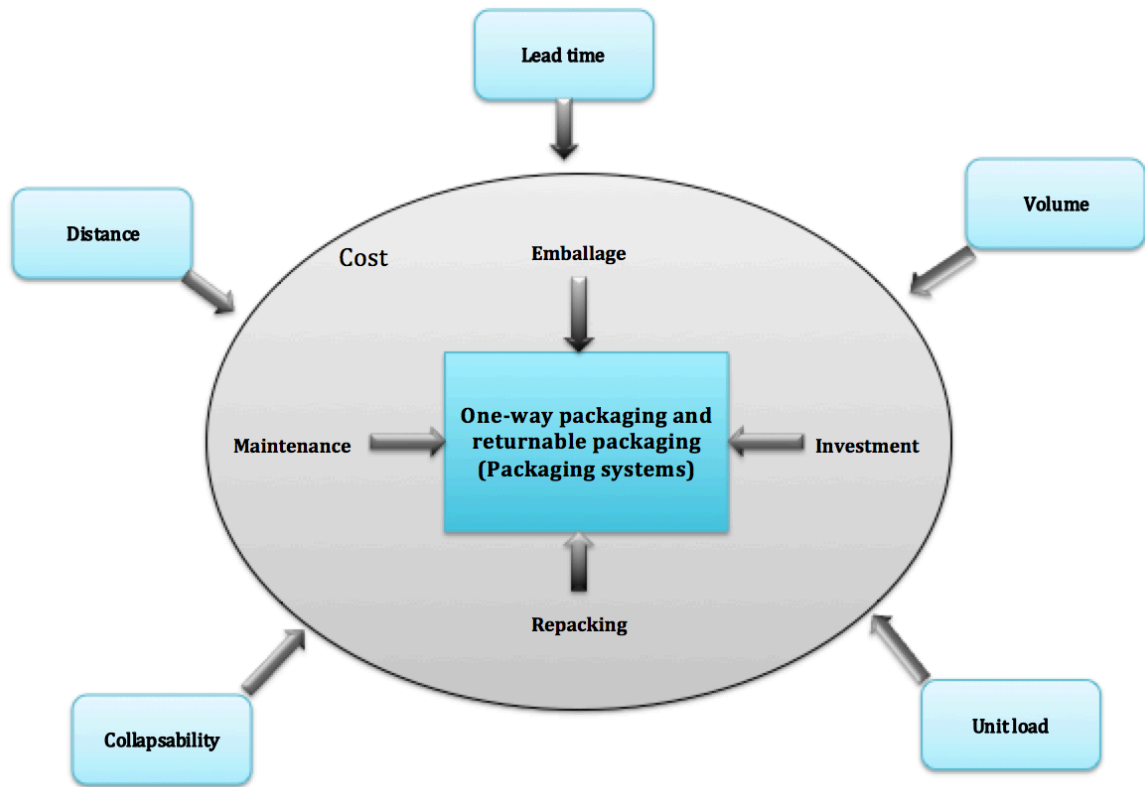


Figure 16. A summarizing model of the empirical data

5 Analysis

The chapter provides answers to the study's research questions by comparing the collected empirical data with the theoretical framework.

5.1 What parameters are crucial and should be considered regarding one-way packaging and returnable packaging decisions?

Figure 13 from chapter 3 and the case company's packaging system parameters, described and illustrated previously in chapter 4, are used here as a base to identify and analyze crucial parameters regarding one-way packaging and returnable packaging. Cost is a central parameter and all parameters are related to cost and therefore are different costs of packaging presented before the crucial parameters.

5.1.1 Packaging costs

The empirical data from the case company showed that cost is an essential factor in every decision making and according to Alsyouf (2001) businesses in general are influenced by cost to achieve cost efficient approaches. Often, companies determine their decisions based on cost in order to achieve cost efficiency. Cost is a major focus for the case company and is seen as an essential central parameter that needs to be considered in order to be competitive in the market. This can be supported by what Alsyouf (2001) suggests: that the survival of any business mainly depends on its ability to compete cost effectively. When deciding what packaging system to use for different transports the decision needs to be based on cost as well as on other parameters. Companies usually strive for long-term profitability and according to Alsyouf (2001) cost plays an important role for improving this. Cost is not seen as an independent parameter at the case company but it is instead seen as a central parameter due to the effect it has on parameters. If a company's focus is on improving cost and cost efficiency, cost has to be set as a central parameter. Based on the theoretical framework the main costs that packaging affects are transportation, handling, waste and quality (product protection), which can be comparable with what was identified from the case company.

5.1.1.1 Transportation

The empirical data from the case company showed that there are benefits to send full trailers to the customers. This is in line with Dominic et al (2000) that it is important to utilize the use of volume of the trailer fully in order to minimize the transportation costs. Table 5 in section 4.5 illustrates the decrease of cost when the volume is higher for one specific country. It is very clear that the cost reduces the fuller the trailer is. The stacking of the emballage in the trailer can also minimize the transport costs. Since one-way packaging are more weight/volume efficient than returnable packaging due to the material it is made out of, the load factor will be higher with one-way packaging if they can be stacked on each other. Cardboard boxes weigh less than returnable plastic boxes and are therefore more difficult to handle in a trailer since they usually tip over.

5.1.1.2 Handling

The empirical data from the case company showed that the repacking costs are 200 sek/emballage. According to Chan et al. (2005) repacking the goods is one of the largest parts of the costs that occur from handling and this is in line with the case

company since repacking constitutes high costs for the company. From the case company, it was showed that one-way packaging requires more repacking than returnable packaging since all one-way emballage does not arrive in the right measurements and can therefore not be placed into the production line directly. Returnable packaging only needs to be repacked if they arrive damaged. According to Chan et al. (2005), elimination of one-way packaging and use of standardized returnable packaging in production will reduce the handling time and therefore will be beneficial to the company. Besides the repacking costs it is showed that the case company has an additional cost that occurs from maintenance and cleaning of the stickers and staples that are put onto the emballage. This is in line with Dominic et al. (2000) that manual labor is an additional cost a company has to bear. The costs of maintenance occur more for returnable packaging at the case company than one-way packaging since emballage need to be cleaned before being reused. The problem is that the cleaning of emballage at the case company is performed manually today and it would be easier for the employees if it was automated.

5.1.1.3 Quality (Product Protection)

The empirical data from the case company showed that cardboard boxes are used for one-way packaging and plastic or wood boxes are used for returnable packaging. This indicates that there is a higher risk of damage for one-way packaging since the cardboard boxes are less robust than returnable packaging. According to Gourdin (2001) the costs of packaging increases with the protection of packaging. This is in line with the case company since one-way packaging is cheaper than returnable packaging due to the different degree of protection of packaging. Returnable packaging is more expensive since it is more resistant compare to one-way packaging. The damage for returnable packaging will not be as high as one-way packaging due to the material that is used for returnable packaging. The empirical data showed that the case company mostly uses trailers during their transports of emballage, which is the cheapest and best alternative when transporting goods. But according to Lumsden (2006) chances of goods getting damaged are higher on road form of transports, which makes it necessary to use returnable packaging as much as possible since plastic is more durable compare to cardboard boxes.

5.1.1.4 Waste

According to Nyström (2006), waste for a company is important to analyze in order to reduce packaging costs. Cost savings in purchasing and disposal can occur by minimizing one-way packaging since one-way packaging brings lots of waste. However, there are also waste costs for returnable packaging. From the case company, it was identified as 2 percent of missing returnable emballage every year. This creates investment costs since the company has to invest in additional returnable packaging in order to replace the missing emballage.

5.1.2 Parameters

There are number of parameters that are crucial and need to be considered for packaging systems in order to decide what packaging system is the most appropriate to use. The crucial parameters from the empirical data that are in line with the theoretical framework are distance, volume, lead-time and collapsibility. The parameters that are not in line with the empirical data are return handling, economic loss of packaging and environment. All these parameters are analyzed and presented below.

5.1.2.1 Distance

Companies have established themselves on new markets worldwide due to the effect of increased competitiveness. This is in line with the case company since their several global customers are located everywhere around the world and they are highly in need of products daily. The distance varies substantially between global customers. The distance between the sender and receiver is crucial to analyze since there can be deal-breaking decisions regarding what packaging system to use. Since the distance varies between several global customers, it is a crucial parameter to consider and should be identified for one-way emballage and returnable emballage since the requirements differ for different countries and locations. This is also in line with what Dominic et al. (2000) mentioned, that distance is one of the major parameter that needs to be taken into account when analyzing what packaging system is the most appropriate system to use during transports to different customers. The empirical data shows that cost for transports differs for different transport distances depending on where global customers are located. As Dominic et al. (2000) describes return transport costs are highly influenced by the transport distance. Companies that use high amount of returnable emballage need to consider the distance even more since they need to take an additional transport route into account. This is in line with the high use of returnable emballage VCC uses and distance becomes therefore an important parameter to consider.

5.1.2.2 Season variation in demand

The empirical data from the case company shows that season variation in demand and unit load is equivalent to volume. According to Dominic et al. (2000), season variation in demand is another crucial parameter that needs to be taken into account regarding one-way emballage and returnable emballage. This is in line with the case company since volume is one crucial parameter that needs to be considered when identifying one-way packaging and returnable packaging since it has a big impact on the transport costs. The case company works with a volume that is often the same and does not vary by season. Even though companies do not have season variation, volume is an important parameter to consider for both one-way emballage and returnable emballage. Despite different season variations, there is still a volume that needs to be taken into account for the different transports to the global customers. The empirical data from the case company also indicates that unit load is the amount of parts an emballage include and therefore is unit load not seen as a separate parameter. Volume is important to identify in order to assure cost efficient transports since the cost will be less as more volume trailers are filled with during transports. This makes it necessary to identify the volume for different transports, see table 5 in section 4.5.

5.1.2.3 Tied up capital

As Dominic et al. (2000) describes, the tied up capital is influenced by the packaging turnover rate and says that the total number of packages in the system will be less with a fast turnover rate. This is in line with the case company since the lead-time has an effect on the tied up capital and a shorter lead-time will reduce tied up capital, which in turn will reduce the warehousing cost, due to the less space requirements. Lead-time is an interesting parameter because of the impact it has on tied up capital. The empirical data shows that lead-time is one of the case company's significant parameter, the time from when the transport of emballage starts from the sender till when it arrives to the receiver, is crucial to consider. The emballage is tied up during transports but for how long depends on the lead-time. Since customers usually are located globally the lead-time to the customers becomes different. The lead-time is therefore necessary for companies to identify in order to know how much capital they are tying up.

5.1.2.4 Return handling

According to Dominic et al. (2000), collapsibility is one crucial parameter, which is the part of return handling. The packages ability of collapsibility has a major impact on the transport costs. From the empirical data it is shown that collapsibility has a big impact on the economical result, which makes it necessary to consider. A package's ability to be collapsible makes a great difference for the transport costs. The case company uses a collapsibility of 1/10 and this is an increased cost saving of 1/10 for the returnable package being returned. Also as Dominic et al. (2000) describes, returnable packaging being collapsible is an advantage to the packaging system as the room needed for storage and handling will be less. Collapsibility is a crucial parameter for companies to consider and it is a parameter that needs to be identified for returnable packaging. The more collapsible emballage, the more amounts of cost savings are possible. This is in line with what Dominic et al. (2000) describes, that collapsibility has an effect on the economical result. The more collapsible, the more cost efficient.

5.1.2.5 Economic loss of packaging

Economic loss of packaging differs for the packaging systems. One-way packaging is cheaper than returnable packaging, which was identified from the case company as well. The life span for one-way packaging is shorter than returnable packaging since one-way packaging only can be used once. Returnable packaging can be used several times before being disposed, which has a big impact on the economical result since returnable packaging is more expensive. Economic loss of packaging is not an important parameter that needs to be considered because it is obvious to every company how long the lifespan is for each packaging system.

5.1.2.6 Environment

According to Kroon and Vrijens (1995) it is important to minimize packaging waste and to put more emphasis on responsible handling of packaging materials. By reusing the returnable packaging it reduces the emissions caused by packaging. Returnable packaging is more sustainable compare to one-way packaging due to the reusability. The empirical data shows that the case company strives to use returnable packaging more than one-way packaging and according to Garcia-Arcia and Prado-Prado (2014) returnable packaging should be used when it is possible. However, even though it is

important to minimize packaging waste, environment is moreover a parameter that is more complex and demanding to achieve. More external considerations need to be taken into account, such as rules and requirements, in order for companies to set environment as a crucial parameter. Companies are not always able to decide upon how to proceed for such parameters due to the set requirements they need to follow in order to be sustainable.

5.1.2.7 Ergonomics

As described in the theoretical framework, ergonomic benefits are higher when using returnable packaging. It contributes to easier handling and better workflow compared to one-way packaging. The case company is aware of the ergonomic benefits of the packaging systems as well and they try to use returnable packaging as much as possible in order to achieve ergonomic benefits in the company. However, ergonomic requirements are similar to environmental requirements in a sense that companies cannot change the set requirements. Ergonomic is therefore not considered as a crucial parameter since companies constantly strives to become better by working for future improvements.

5.2 Summary

In this section a summary of the answer to the first research question is presented, see figure 17. The theoretical framework has been the basis to answer the research question and the answer is based on the similarities between the empirical data and the theoretical framework. The parameters that are crucial and that a company should consider for one-way packaging and returnable packaging decisions are distance, season variation also referred to as volume, tied up capital also referred to as lead-time and return handling, which can be referred to as collapsibility. Cost is a central parameter and all these parameters are related to cost.

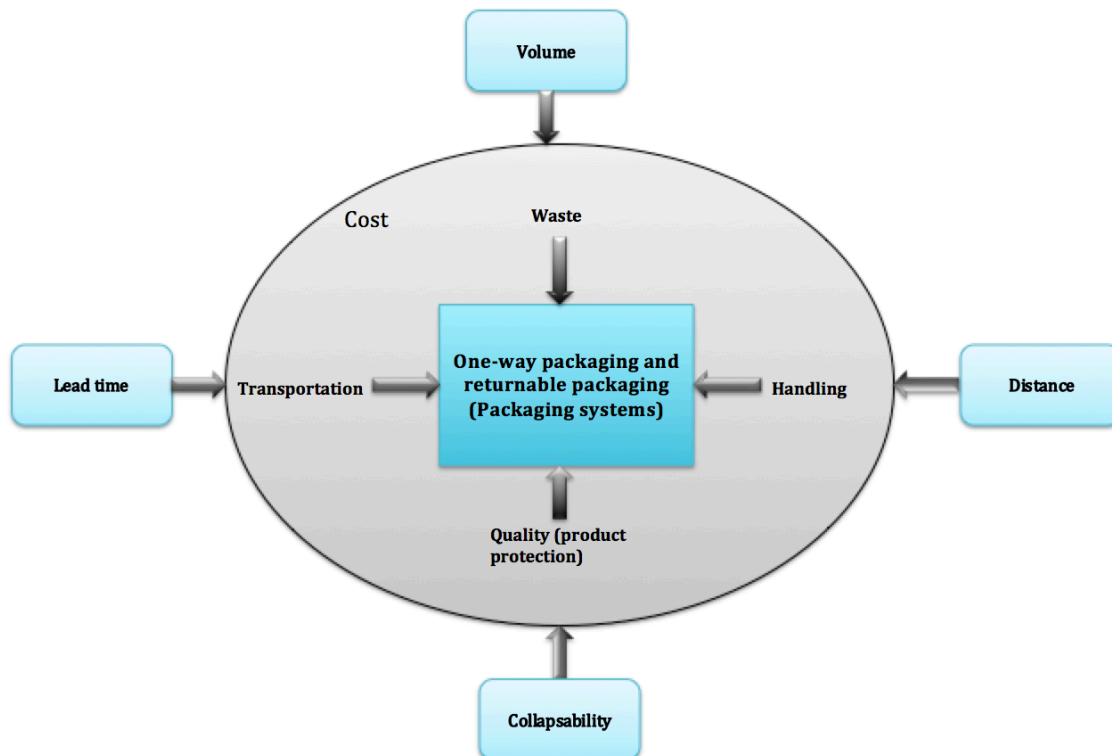


Figure 17. Crucial parameters for one-way packaging and returnable packaging

5.3 How do the identified parameters interact with each other in terms of decision for a tipping point regarding one-way- and returnable packaging?

By analyzing the parameters that were identified from the first research question, interactions among the parameters can be formulated as well as suggestion for a tipping point regarding one-way- and returnable packaging. The theoretical framework and the empirical data from the case company are used to answer the second research question.

5.3.1 Volume and Distance

According to Dominic et al. (2000), distance and volume are two of the crucial parameters and therefore these parameters constitute the most significant interaction. This interaction is also in line with the case company's view of interaction among parameters. The relation between volume and distance is based on cost. By setting volume and distance against each other it creates different costs of transports to their customers. The cost to their customers will be different depending on the distance and volume. The transport cost is measured by how long the distance is and how much volume that is going to be sent to the specific customer. The longer distance the higher cost and the higher volume the less cost. According to Dominic et al. (2000), one-way packaging is the most appropriate system to use when the transport distance is long and the volume is high since the cost of using returnable packaging for long distances would be very high. Even the cost of sending the returnable packaging back would constitute high amount of costs. This is also in line with the case company since they uses one-way packaging during long distances and spontaneous orders.

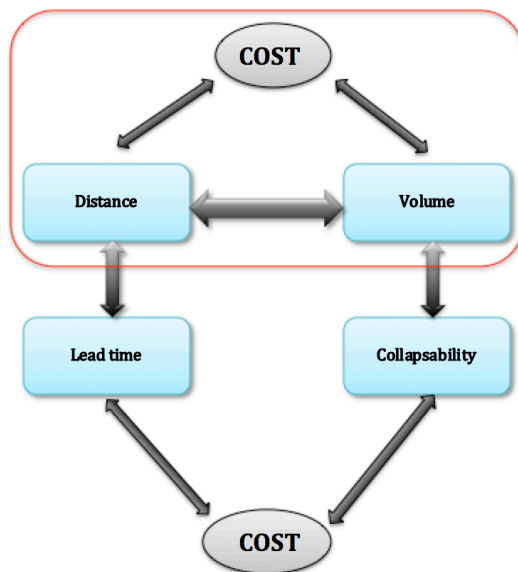


Figure 18. Interaction between distance and volume (the red marked area)

5.3.2 Distance and Lead-time

Based on the empirical data from the case company distance and lead-time are another two parameters that constitute an interaction. The relation between distance and lead-time is based on cost and the interaction presents the cost of tied up capital. According to Pewe et al. (2000) the number of packages in the system will be less with a fast turnover rate. The shorter lead-time the less cost of tied up capital for companies. The longer distance the longer lead-time, which contributes to higher costs for the company. It is important to understand the different distances to its customers in

order to plan the tied up capital around the lead-time due to the additional costs that can occur. The different packaging systems represent different amount of lead-time. One-way packaging is transported once from sender to receiver before being disposed while returnable packaging has to be sent back and reused for other customers. This is in line with the case company's packaging systems. This means that returnable packaging have an additional lead-time for the return transport. This creates higher costs for returnable packaging.

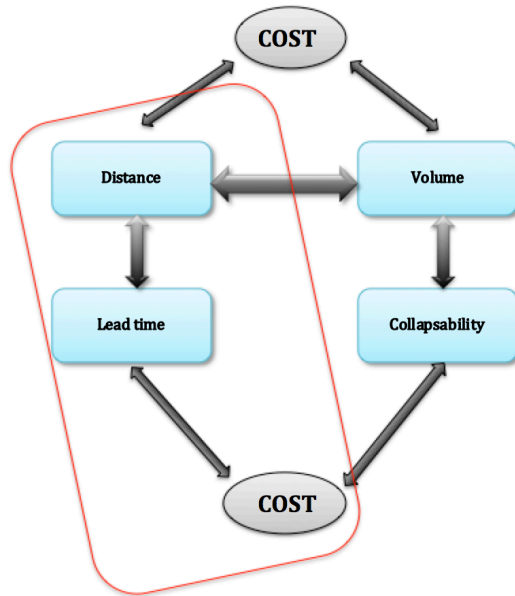


Figure 19. Interaction between distance and lead-time (the red marked area)

5.3.3 Volume and Collapsibility

There is also an interaction between volume and collapsibility. It is possible to retrieve cost savings in volume by interacting these two parameters with each other. As Dominic et al. (2000) describes, collapsibility is a part of return handling and returnable packaging being collapsible is an advantage to the packaging system as the room needed for storage and handling will be less. The interactions have an effect on the economical result since the costs will be less if the volume decreases and makes the returnable packaging collapsible. As identified at the case company, the ability of collapsibility will be higher the lower the volume is and this leads to more cost savings for companies. VCC uses a collapsibility of 1/10 as mentioned previously, this proves that collapsibility has an effect on the economical result since the cost for the return transport will be 10 times less than the cost for transport of full volume to its customers. However, in order to fully benefit the collapsibility it is better to return full trailers of collapsible emballage. This will in turn have an effect on the emballage since the returnable emballage will be locked in transports for longer periods of time. In order to reduce the waiting time for a trailer to be fully loaded with collapsible packages, a company can cooperate with other companies by sharing a trailer for the return transport. It is important for a company to have sufficient amount of emballage so that they can manage the system even though there are locked emballage in transports. Therefore, it is necessary for a company to invest in returnable emballage. The cost savings of returnable emballage being collapsible for the return transport needs to be used for investment of returnable emballage in order to always have an operating system.

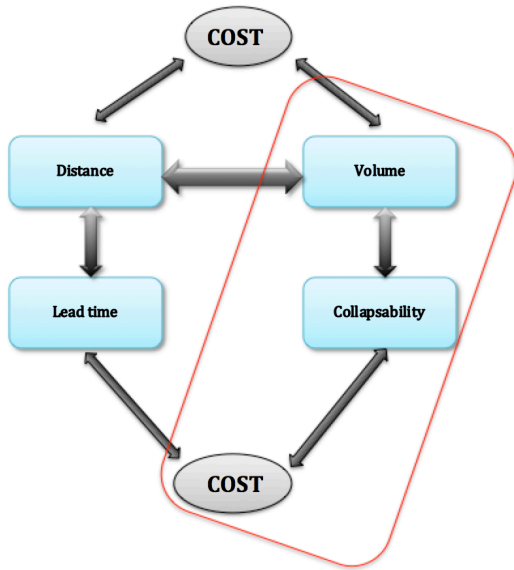


Figure 20. Interaction between volume and collapsibility (the red marked area)

5.3.4 Tipping point

The presented interactions in the previous section 5.2.1 are necessary in order to define a tipping point for one-way packaging and returnable packaging. According to Ax et al (2011), two or more parameters have to interact with each other in order to figure out the tipping point, the optimal choice. Lead-time has a significant role on distance since the lead-time for a packaging is decided based on the distance to the customer. Depending on how long the distance is to the customer it determines the lead-time. Collapsibility is connected to volume since the volume differs depending on how collapsible a returnable packaging is. Packages ability to be collapsible makes a great difference in volume. Distance is also connected to volume, see figure 11 in section 3.5. By setting volume and distance against each other it creates different costs of transports. Volume functions as an independent parameter since the volume ordered from the customer cannot be changed. The customer and its order sets the basis for the interactions, which in turn makes the company to make the optimal choice.

5.4 Summary

In this section, a summary of the analysis is presented. The identified parameters from the first research question contribute to interactions, which were described in the second research question. The volume of the customer order is the foundation of the interactions, which in turn contributes to a decision basis for what packaging system is the most beneficial to use, see figure 21. The figure shows four different cubes of the four crucial parameters that should be considered regarding one-way- and returnable packaging decisions. Cost is also included in every cube since it has an effect on the parameters. The volume cube indicates that cost will decrease the fuller the trailer is. The collapsibility cube indicates that cost will decrease with increased collapsibility of emballage. The distance and lead-time cubes indicate that cost will increase with longer distance and lead-time. The arrows between the different cubes show the interactions that were described in answered to the second research question. The figure provides a better understanding of the relations between the parameters, which in turn will contribute to that a tipping point can be defined. The decision of what packaging system to use might differ every time since the decision is influenced

by the crucial parameters and their interactions. See appendix 3 for an illustration of how to define a tipping point based on the four crucial parameters.

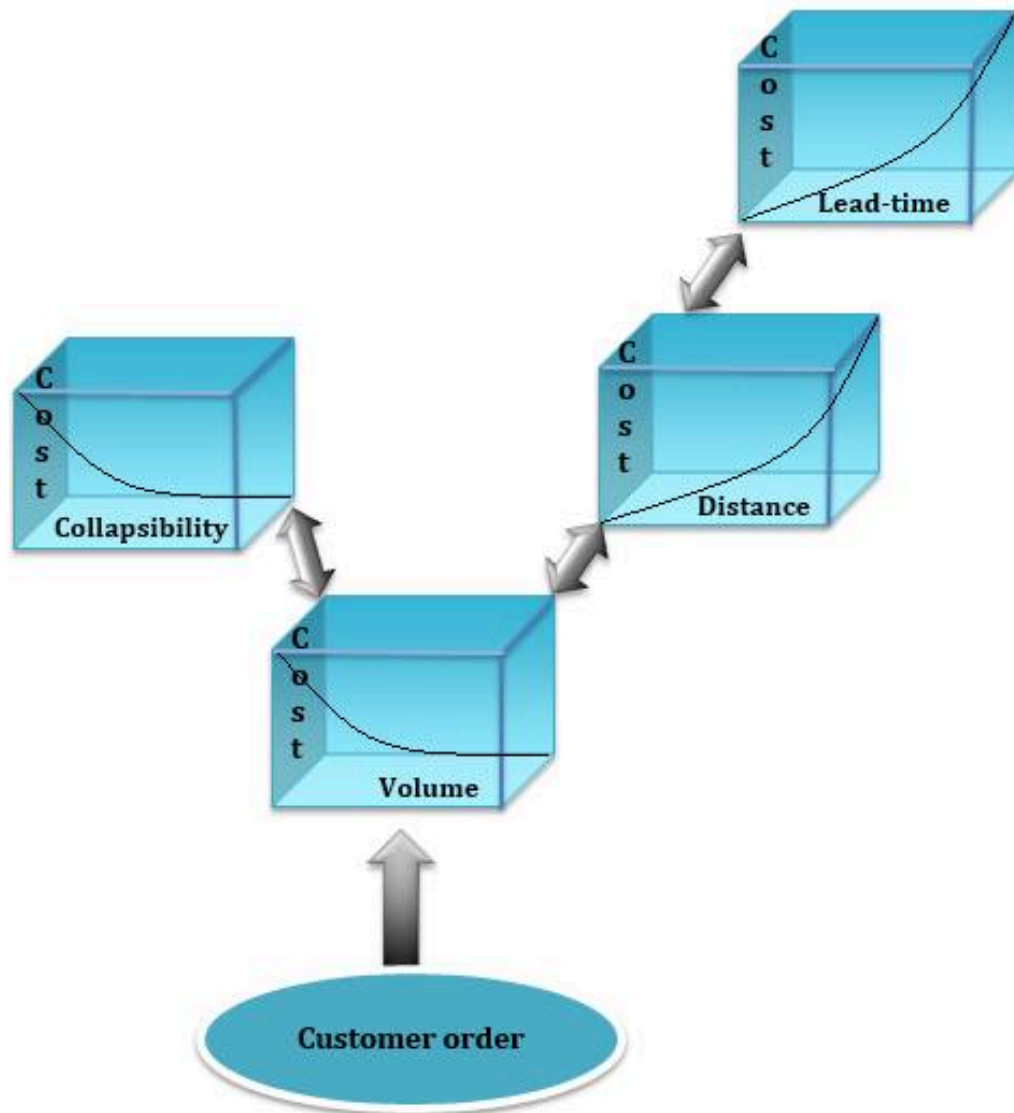


Figure 21. A summarizing model of the analysis

6 Discussion and Conclusions

This chapter provides a discussion of the study's result. Further, the managerial implications are described and the study's limitations are discussed. The study's conclusions are also presented in this section. The chapter concludes with suggestions for further studies.

6.1 Result discussion

The results from this study have shown that four perspectives on packaging system decision making are central. First, the actual definition of parameters, second, the interactions among parameters, third, the way in which the interaction among parameters result in the calculation of a tipping point, and last, how these parameters and their interactions impact the cost efficiency of the company.

The purpose of this study was to “evaluate crucial parameters for decision making of packaging systems in order to assure cost efficient transports”. The crucial parameters are identified as volume, distance, lead-time and collapsibility. By understanding the characteristics of volume, distance, lead-time and collapsibility, a better understanding of emballage features is provided. This, in turn, will give better ideas of what packaging system to use. Considering several crucial parameters when making a decision gives a higher complexity to a decision basis and ultimately results in better choices for a company. This is in line with what Johansson (2009) mentions: it is beneficial for a company to consider more than one parameter in order to find the optimal choice. If parameters are not taken into account when making decisions regarding packaging systems it can result in inaccurate choices, which will influence a company's economical result. In this study cost is recognized as a central parameter and all the other parameters are related to cost. As Alsyouf (2001) emphasized, the ultimate goal of every decision is to maximize profitability by reducing cost and this fact impacts the decisions with regard to the various parameters.

As Dominic (2011) emphasized it is important to understand the interactions among the different parameters that affect packaging systems. In this study are the interactions among the crucial parameters identified between volume and distance, distance and lead-time, and between volume and collapsibility. Therefore, in order to be cost efficient within packaging systems, it is of significance for companies to make decisions regarding what packaging to use based on the combination of these three interactions. The interactions together bring a cohesive answer of what packaging system to use in order to receive the most savings in both time and cost depending on the volume of the order and the location of the customer.

This study shows how a tipping point can be defined by evaluating crucial parameters and the interactions among them. This is in line with Johansson et al.'s (2007) emphasis on that parameters need to be set and related against each other to find the optimal choice for decision making of packaging. It is necessary for a company to make right decisions in order to be cost efficient, especially due to the emergence of new demands in the sector of packaging logistics. In this study it was shown that the crucial parameters and their features help a company to define a tipping point for decisions of what packaging system to use. It is possible to define a tipping point when a company gets a customer order. It is then the volume of the order that is the foundation of the interactions. By understanding this, it helps the company to make

the optimal choice. As Shapiro (2003) emphasizes, a tipping point works as an important position to the success of an operation.

It is vital to have a detailed decision making as Dominic (2011) emphasizes on, for companies that strive to develop their competitiveness on the market. If a company does not presuppose a detailed decision making where the crucial parameters and the interactions among them shows the most optimal choice for this company, there is a risk of inaccurate outcomes, which in turn will have an effect on the economical result. Cost is an important factor in determining the success of the business and maximizing profit is key for any company. It is therefore important to understand that it always should be economical for a company to use a particular packaging system.

6.2 Managerial Implications

In order to see which packaging system is the most beneficial to use for different customers located worldwide it is important to analyze and compare the company's different packaging systems since they have different features. When you work as a packaging logistician it is crucial to absorb the approach described below:

1. Identify what parameters are crucial for a company's packaging systems in order to be cost efficient. This by taking out crucial parameters that affect packaging systems. It is possible by looking at the transport flow to see what kind of questions that comes up when deciding what packaging system to use for different transports. It is important to differentiate the parameters that affect packaging systems since not all parameters are of equal importance for the cost.
2. Understand the interactions among the crucial parameters in order to define a tipping point. It is possible by looking at the connections the parameters have with each other. It is important to figure out what parameters interact since they need to be set against each other in order to define a tipping point, so the right packaging system can be chosen.
3. Make decisions regarding packaging systems based on a tipping point since it shows the optimal choice for a company. A decision basis where a customer order sets the base for interactions among the crucial parameters is important to understand in order to define a tipping point from different customer orders. Knowing what packaging system to use for different customers will be beneficial for the company. It is important to presuppose a decision basis for every customer order in order to be cost efficient since the decisions will differ every time due to the different distances to the customers and the different sizes of orders that customers have made.

6.3 Limitations

When analyzing crucial parameters for decision making, consideration was only given to industrial packages that are used for transports between companies. This enables a solution that is profitable from one perspective, which makes it important to consider the entire value chain to find the solution that is economically profitable overall. The crucial parameters identified would not be the same if customer packages also were taken into account. It would have added on complexity to the study, which would have generated different results. There would be different parameters to consider for

decision making if the customer packages were taken into account since the packages need to look good in order to attract the customers.

The focus of this study was on ensuring cost efficient transports, which led to cost being a focus point. This means that cost was the main focus throughout the study and other focuses such as environment, ergonomics or quality could have generated different results. Today, companies focus most on being cost efficient rather than being environmental, quality or ergonomic driven. Cost is an important factor in determining the success of the business and maximizing profit is key for any company. Therefore, environment, quality and ergonomics are not as significant as cost since they are better for long-term success. They are still important to consider since they have a big impact on the cost and in order to assure cost efficient transports it is crucial to find the solution that is economically profitable overall.

Since the study was conducted at one singular case company, the results could have differed if additional companies were taken into account. Focusing on a singular company, authors could establish better contact with the case company and spend more time at their packaging department. This in turn resulted in good accessibility to important sources of information, which facilitated the collection of the data. The object of the study has also resulted in a focus that is more situation-specific and this limitation of the collection of data influences the study's generalization to some extent. A certain level of detail is necessary in order to generate a well-reasoned contribution, which also enables a better understanding. The case company for this study was suitable for the data collection since it is a global company that distributes products globally. If the data collection was conducted from another industry with a different specialization it could also have generated different results since it would have required an analysis of different perspectives and conditions.

6.4 Conclusions

The research has shown that decision of what packaging system to use for different transports can become clearer by basing the decision on crucial parameters for packaging systems. By analyzing volume, distance, lead-time and collapsibility for every customer order, it enables a better understanding of what packaging system to use for different transports. Volume is a given parameter in every customer order and constitutes the basis for the other parameters.

Based on the interactions among the crucial parameters, a tipping point can be defined from a decision basis for packaging systems in order to be cost efficient. By defining a tipping point for different customer orders it enables a company to make the right decision of what packaging system to use during transports, one-way packaging or returnable packaging. By understanding the different packaging systems and how to use them in a cost efficient way, companies can grow, compete in the market and still maintain a profitable packaging department.

6.5 Further research

Since the study was conducted at one singular case company there is an interest with a similar focus to investigate additional object of study and expand the contribution of understanding for packaging systems. A differentiation of industry specialization would also provide an additional dimension to the problem area where other perspective and conditions enables enhanced analysis. It would also be interesting to

handle the study quantitatively for further research and actually calculate the tipping point.

This study only concerned standard emballage in one-way- and returnable packaging but as identified from the interviews there are other kind of emballage within one-way- and returnable packaging such as heavy duty and special emballage. For further research it would bring an interesting perspective to include these emballage as well in order to broaden the perspective of packaging systems. The potential of achieving cost efficiency for transports of emballage would also improve. Also setting the focus on environment, quality or ergonomics instead of cost would bring a different outlook to the study. To conclude, it would be interesting to add complexity to the study.

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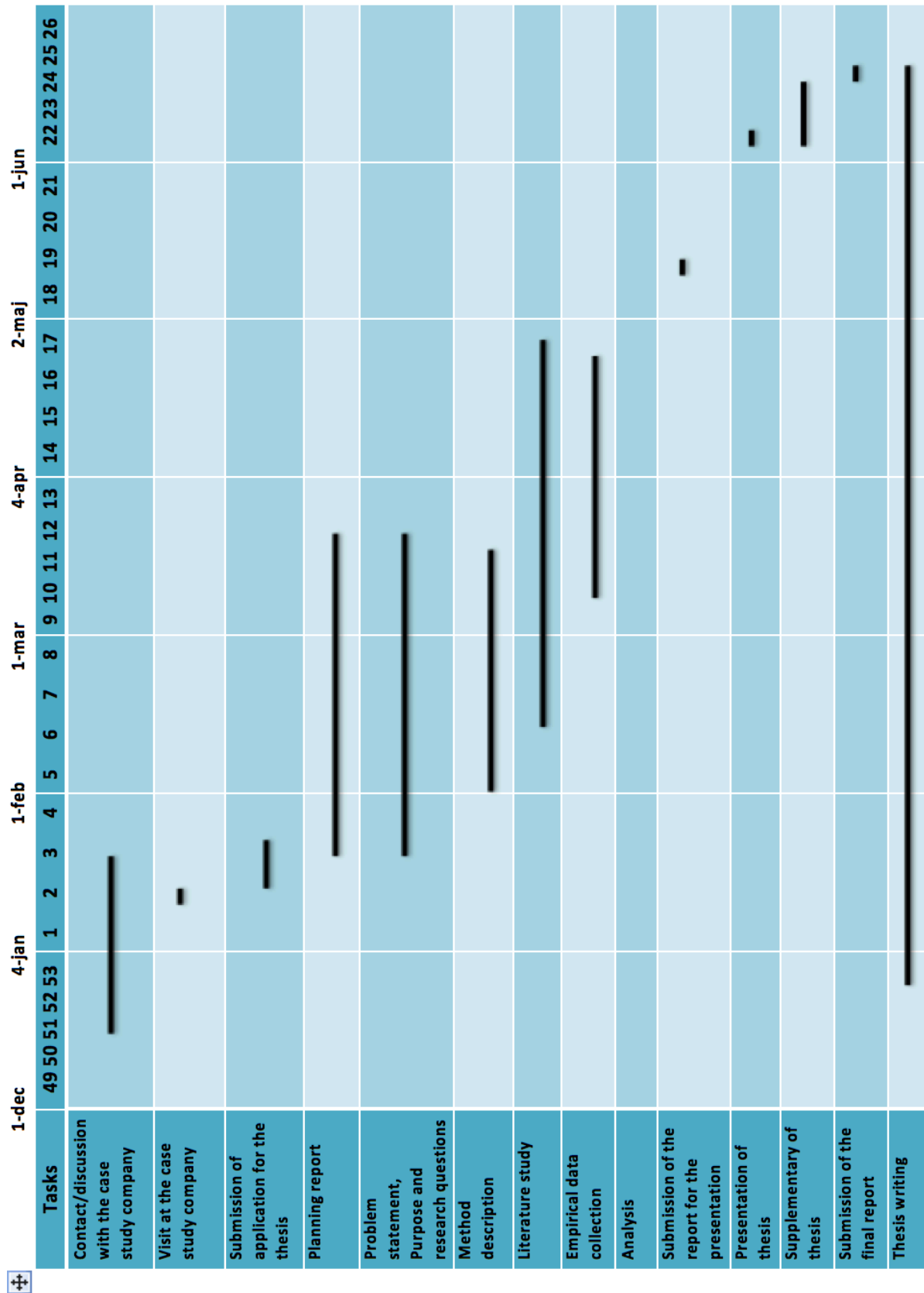
Appendices

Appendix 1. Schedule of the thesis research process

Appendix 2. Interview guide

Appendix 3. Illustration of how to define a tipping point

Appendix 1 - Schedule of the thesis research process



Appendix 2 – Interview guide

Packaging systems

- What packaging systems are used at Volvo Cars Corporation?
- What different parts do the packaging systems consists of?
- Which packaging system is used most during transportation? Why?
- How are the decisions taken regarding what packaging system to use for different orders?
- How are decisions taken when spontaneous orders are coming in? Which packaging system is used? Why?
- Have there occurred any complications regarding the used packaging systems? If yes, what types of problems have occurred?
- How many emballage are wasted or/and occurs damage during every transport of each packaging system?
- Repacking is enhanced in theory. How is repacking connected to the packaging systems?
- Is there a difference in how repacking is performed for the different packaging systems?

Repacking

- What activities does repacking consist of?
- How much repacking needs to be carried out in general for returnable packaging?
- How much repacking needs to be carried out in general for one-way packaging?
- Is there any activities within repackaging that can be reduced in time and cost?

Packaging cost rates

- Which packaging system is cheapest to use?
- How much does one returnable packaging approximately cost?
- How most does one one-way packaging approximately cost?
- How much does it cost for Volvo Cars Corporation to repack one one-way packaging?
- What is the investment cost for returnable packaging?
- During how many years is the investment cost depreciated?

Parameters

- What different parameters are involved for packaging systems?
- What parameters does VCC see as most important? Why?
- How does the parameters interact with each other?
How is cost related to parameters? Is cost driven as a central parameter? If yes, why?

Appendix 3 – Illustration of how to define a tipping point

A= One-way packaging

Total cost of A = Cost of a complete package (*box, a pallet, lid and X frames*) × Volume + Transport cost (*dependent on volume and distance*)

B= Returnable packaging

Total cost of B = $\left(\frac{\text{Total investment cost of one package with the interest}}{\text{Expected life time (working } \frac{\text{days}}{\text{year}})} \right)$
× Loop time (*leadtime* * 2) × Volume + Transport cost (*dependent on volume and distance*) + Transport cost (*dependent on volume and distance*) × Return volume (*volume of incoming goods* × *collapsibility*)

Total cost of A > Total cost of B → Choose Returnable packaging

Total cost of A < Total cost of B → Choose One-way packaging