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Packaging usage for spare parts distribution

A case study of packaging products at a spare parts distribution center

Bachelor's thesis in Economics and Manufacturing Technology

HILDA DAHLÉN
SANDRA SPRÅNG

Department of Technology Management and Economics
CHALMERS UNIVERSITY OF TECHNOLOGY
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Department of Technology Economics and Management
Division of Supply and Operations Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Telephone: +46 31 – 722 10 00

ABSTRACT

Volvo Cars is a manufacturer of cars and currently there are approximately six million Volvo cars on the roads. To manage the distribution of spare parts for the cars, Volvo have implemented Local Distribution Centers (LDC's) that handle the spare part distribution to dealers within a two-hour radius driving distance. This distribution process requires packaging for the spare parts. The processes and procedures connected to packaging are not standardized and Volvo want to improve the control of the packaging flow.

To get a better understanding of the packaging connected to the spare parts distribution, an investigation has been conducted that consists of mapping of the current state, examination of the packaging products that are used and a study of the costs and ordering connected to the packaging flow. The investigation has been made on a selected LDC in Maastricht.

The mapping of the packaging flow showed that improvements regarding the information flow as well as the return flow can be made. If the information flow is improved regarding better and more standardized routines connected to updating the inventory, the control of the flow can be improved as well. If the return flow is improved and further utilized, more packaging products can be reused and the costs may decrease.

The investigation of packaging types showed which secondary packaging was preferred by the operators and which types that were easiest to handle. This investigation showed that the blue boxes were seen as preferable, with comparison to the other secondary packaging types. Furthermore, the same process was made for the tertiary packaging as the secondary packaging. It was shown that the HD boxes are beneficial, with comparison to the One Way boxes.

There is also an analysis of which secondary and tertiary packaging that is most economical. This investigation showed that the plastic bags were most beneficial, with comparison to the other secondary packaging types. Furthermore, the HD boxes, if reused, are the most beneficial in comparison to the other tertiary packaging types.

When investigating the ordering of packaging products, it was found that the LDC orders less packaging products than expected. This can be due to wrong estimations or because the inventory before and after the period of investigation is unknown. Furthermore, an analysis of the number of packaging products showed that it is possible to reduce this number.

The approaches chosen to investigate the usage of packaging in Maastricht have been sufficient for the purpose of the thesis.

PREFACE

This bachelor thesis entails 15 credits and is a part of the education program Economics and Manufacturing Technology at Chalmers University of Technology, Gothenburg, Sweden. The thesis work was conducted in the spring of 2016 at Volvo Cars at the division Market Area Europe.

Firstly, we would like to take this opportunity thank our examiner and supervisor at Chalmers, Lars Medbo, and our supervisor at Volvo Cars, Anna Weimers, for your support and guidance during the work with this thesis.

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Gothenburg, June 2016
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1 INTRODUCTION

This chapter will begin with a background for the thesis which is followed by the purpose, scope and problem definition. Then the disposition of the thesis and a list of acronyms are presented.

1.1 Background

In a fast growing and changing global world, the demands regarding new technologies and needs will be a very important factor to take in consideration for the companies to survive. The automotive industry started in the end of the 19th century, and the range of cars have increased over the last decades. In 2010 there were over 10 billion cars in the world (Sousanis, 2011), a number that is constantly growing.

Today, there are approximately six million Volvo cars on the roads. Volvo were founded by Assar Gabrielsson and Gustav Larson in 1915. In 1927, the first Volvo was on the automotive market and Volvo were founded. In 1999, Volvo Car Corporation and Volvo Group became two disjointed businesses. Today Volvo Car Group sell cars in approximately 100 countries.

Volvo have a policy to have spare parts for all car models until 10-15 years or longer after the model is no longer produced. This, in combination with the overall increasing sales of cars and different car models, has led to that the demand for spare parts has grown. Today, there is a high competition in the business for spare parts to cars. The original spare parts compete with alternative spare parts produced by companies that do not sell the original product.

To increase Volvo's competitiveness regarding spare parts, a division at Volvo, Customer Service, has during the last 10 years implemented a concept with Local Distribution Centres (LDC's) in Europe. The LDC distributes spare parts to dealers, who have a small range of spare parts for sale and also have a workshop for repairs of Volvo Cars. The LDC's have replaced the dealer's own inventories so that the dealers only need a small safety stock of high frequent parts. When dealers need spare parts, they order them from the LDC, which delivers spare parts two times daily and one time during the night. Currently there are 26 LDC's in Europe distributing spare parts to dealers. The spare parts that are delivered, need packaging to protect the products and make the handling easier. At the LDC, one order is packed separately in an individual package which is called secondary packaging. In some cases, depending on when or where the orders are distributed, this package is put into a larger packaging type, for example a pallet, that is called tertiary packaging.

The concept of LDC's has evolved over time and with different project managers, third-party logistics and varying market demands which has caused a lack of standardization in the processes and procedures connected to the packaging. For example, the LDC's can order packaging products from several sources. Volvo has an own supply of packaging products at the Central Distribution Center (CDC) in Gothenburg, Sweden. The External Stock Control (ESC) are responsible for sending this out to LDC's. The LDC's can also choose to order the packaging

products directly from the same supplier as Volvo uses, Papyrus. In some cases, the LDC also orders from a local supplier. The packaging products that the LDC's order vary as well, both in in terms of what types of packaging and the number of types that are ordered. These are some examples of how the LDC's deviate from one another which can affect the costs of the packaging.

After the separation between Volvo Group and Volvo Cars, they still shared a part of the business, for example they had a pool of packaging together. After the split, this system became problematic and Volvo Group took over most of the pool packaging, also called Volvo packaging. The Volvo packaging consists of wooden pallets with collars. The latest years, the LDC's in the Benelux area has exceeded the budget addressed for packaging. Because of the not completely standardized processes and various factors affecting costs at the LDC's, Customer Service are not sure of the reasons for the budget deviation. Therefore, Customer Service would like to get better understanding of the packaging flow in the LDC's.

1.2 Purpose

The aim of this thesis is to give a comprehensive understanding of the current situation and the performance of the packaging flow and usage of packaging products for spare parts distribution connected to the LDC. This will involve the flow of packaging products to the LDC as well as the packaging flow for spare parts from the LDC to dealers. The usage will focus on the different packaging types that are used and their characteristics.

1.3 Scope

- The LDC that is investigated is the LDC in Maastricht, the Netherlands.
- The LDC in Maastricht also consists of a Support Distribution Center (SDC), which supplies France with spare parts.
- The flows that will be analyzed are the physical and the information flow.
- The flow of new packaging products to the LDC in Maastricht can consist of different supply chains from ESC and Papyrus.
- The flow from the LDC in Maastricht to dealers is defined as the packaging used to transport spare parts to different dealers. All dealers both sell spare parts and perform car service. Some of the packaging products can be reused, which means that the flow of packaging products can return from dealers to the LDC.
- The packaging flow in the LDC is focused on the process and usage of different packaging types.
- The packaging flow directly from CDC to dealer will not be included.
- Volvo packaging is not part of the scope. The Volvo packaging consists of wooden pallets and collars and was part of the common packaging pool with Volvo Group.
- Spare parts, and its packaging, directly delivered from supplier to dealer and LDC's, or cross docked at the LDC, are not part of scope.

1.4 Problem definition

In 1999 Volvo Car Cooperation became two separate businesses, Volvo Group and Volvo Cars. At that time, they still shared some of the business, the packaging products of the spare parts distribution was one of them. The packaging products extended of Volvo packaging, which was packaging consisting of wooden pallets and collars that was returned from dealers, and then was reused. After the split, this system became problematic and the business was separated in two. With the split, Volvo Group took over the packaging products regarding the Volvo packaging, therefore it became necessary for Volvo Cars to develop a new packaging system. A solution was to start using one way packaging, because the implementation of a return flow system can be time and cost consuming.

The concept of LDC's has evolved over time under different circumstances during the last 10-15 years. This, in combination with the development of a whole new packaging system, has resulted in a varied standard for processes and procedures regarding packaging in the LDC's. The current situation is that the LDC's in Europe have their own routines for ordering packaging, both regarding when to order and what volume. The usage is different as well, as the number of times reusing different packaging can differ between different LDC's. In some cases, the packaging might not be reused at all. Different packaging suppliers are available which has led to that the packaging used varies from LDC to LDC.

A budget for packaging products was made for the packaging costs at LDC's in Europe based on historical data with consideration to volume increase in spare part distribution. It has shown that the forecasted budget from 2015 does not correlate to the current situation in the LDC's. This has raised questions about the system's performance regarding packaging products and the flow of packaging.

From the problem definition above, the following questions have been identified:

- How is the current packaging flow, both regarding physical and information, structured?
- What are the different types of packaging that are used in the LDC in Maastricht and how are they used?
- How is the cost of packaging products related to the packaging usage?

1.5 Disposition

A brief summary about the different chapters to clarify the structure of this thesis is presented.

Chapter 1 – Introduction
The background, purpose, scope and the problem definitions are described.

Chapter 2 – Method
This chapter describes how the thesis is performed. The research strategies, how the data collection gathering was done and the methods that were used are described. The data collection techniques used was interviews, observations and literature. The methods used was Mapping of activities. Furthermore, the Validity and Reliability are described.

Chapter 3 – Frame of reference
In this chapter the theory used for this thesis is presented. The theory is the basis for the analyze and discussion. The theory is necessary to become familiar with the different types of packaging products that are used and their functions and different material. Furthermore, the philosophy Lean is presented regarding purpose and methods that are suitable for this thesis.

Chapter 4 – Empirical findings
In this chapter the findings of the data collection is presented. The current situation is presented with a mapping of the information flow and physical flow. Furthermore, the different packaging products are presented.

Chapter 5 – Analysis
In this chapter the analysis of this thesis is presented. The analysis is based on the theoretical framework and empirical findings.

Chapter 6 - Discussion
In this chapter a discussion of the empirical findings, the analysis and different approaches to take in account is presented. Furthermore, a discussion of the questions that have been answered in the thesis is conducted, and where the answers to these questions can be found.

Chapter 7 - Conclusion
This chapter summarizes the findings of the thesis. The summary is based on theory, empirical findings and the questions that have been answered in the thesis.

Chapter 8 - Recommendations
This chapter present the findings from the chapter empirical findings, analyze and discussion which is recommendations for the company. Furthermore, findings are presented which the company can take in further research to get a better understanding about approaches to take in account.

1.6 List of acronyms

CDC - Central Distribution Centre
ESC - External Stock Control
HD - Heavy Duty. A type of tertiary packaging consisting of wooden pallets and collars.
LDC - Local Distribution Centre
SDC - Support Distribution Centre

2 FRAME OF REFERENCE

In this chapter, the theoretical framework of the thesis will be presented regarding facts, methods and theories. The chapter is divided into different sections Lean production, Packaging and Pareto principle. The theory is necessary to become familiar with the different types of packaging products as well as methods that are used in this thesis. In the first section the philosophy lean is presented and also some of the principles and methods that are used in Lean which is applicable for this thesis. In the second section general information about packaging and its material is presented. Furthermore, the pareto principle is presented to get a better understanding of the usage of different packaging types.

2.1 Lean production

In this section, a brief summary about lean production is presented that are suitable for this thesis. The sections is divided in Lean philosophy, waste, standardized tasks and mapping.

2.1.1 Lean philosophy

In the 1980's Toyota got attention for the great quality and efficiency of their production system, which increased in the 1990's when the book The Machine that Changed the World was released and made the term "lean production" known in the whole world. Lean production was invented by Toyota and refers to their production system (Liker, 2004). Lean is a philosophy that grew from the Toyota Production System and the main idea is to maximize customer value by minimizing waste, or muda in japanese (Liker & Meier, 2006). To do this, the operation should be viewed as a value stream and there should be work with continuous improvement, kaizen. Liker (2004) have formulated 14 principles of Lean production. Furthermore, these principles describe strategies that can be implemented in the organization to create improvement. Liker (2004), describes the 14 principles and they are presented below:

Principle 1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.
Principle 2. Create continuous process flow to bring problems to the surface.
Principle 3. Use "pull" systems to avoid overproduction.
Principle 4. Level out the workload (heijunka). (Work like the tortoise, not the hare.)
Principle 5. Build a culture of stopping to fix problems, to get quality right the first time.
Principle 6. Standardized tasks are the foundation for continuous improvement and employee empowerment.
Principle 7. Use visual control so no problems are hidden.
Principle 8. Use only reliable, thoroughly tested technology that serves your people and processes.
Principle 9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
Principle 10. Develop exceptional people and teams who follow your company's philosophy.
Principle 11. Respect your extended network of partners and suppliers by challenging them and helping them improve.

Section IV: Continuously Solving Root Problems Drives Organizational Learning
Principle 12. Go and see for yourself to thoroughly understand the situation (genchi genbutsu).
Principle 13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
Principle 14. Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen). (Liker, 2004)

2.1.2 Standardized tasks

In this section principle number six will be further explained, because this principle is suitable for this thesis and will get a better understanding of why some of the tasks should be standardized. Liker (2004) describes standardardized tasks as a standard and a common work procedure. Furthermore, he writes that the standardized task should content of the best practise for the moment. Moreover, he claims that the standardization work procedure is the base and makes it possible to have an iterative improvement process.

2.1.3 Waste

The waste is identified as activities that do not contribute value to the product. Liker (2004) has described eight types of these non value-adding activities, or wastes, which will be listed as follows:

- Overproduction - to produce more than is needed, or before it is needed. This can be seen as the worst of the wastes, because it generates several of the others.
- Waiting - time that is not spent working for reasons such as waiting for a machine to get ready, information to be delivered or the next process step. This can also be caused by delays, downtime or bottlenecks.
- Unnecessary transport - moving material, parts or finished goods distances that are avoidable or longer than needed.
- Overprocessing - processing that is not needed or is inefficient due to poor design of tools and products. Waste is also generated when a product is given higher quality than demanded.
- Excess inventory - can be for example unnecessary high levels of raw material, work in process (WIP) and finished goods. A large inventory can contribute to hiding problems such as imbalance in production, late deliveries from suppliers, defects, downtime, and long setup times.
- Unnecessary movement - motion made by the operators that is unneeded, for example reaching for a tool, looking for an object or stacking parts. Walking is also considered a waste.
- Defects - producing products with flaws that need to be corrected. The processes of rework, disposal and inspection are seen as wasteful.
- Unused creativity - to not take advantage of the operators' resourcefulness by not engaging or listening to them can lead to losing time, ideas, skills, improvements and learning opportunities.

2.1.4 Mapping

Value stream mapping is a tool originating from Lean Manufacturing, which is a step towards a more value streamed orientation. Taiichi Ohno had a prominent role in the creation of the Toyota Production System and he wanted to create a value stream in the manufacturing process. He requested a tool that visually displayed the material and information flow at the same time as he wished to stop workers from only look at individual processes and instead see the processes as parts of a system, and this has led to what we call value stream mapping (Liker & Meier, 2006). The value stream map illustrates processes, material flow and information flow of a chosen product or product family and develops the system to become value flow oriented. (Liker, 2004).

Inspired from the value stream mapping, Volvo have an own tool to map the value flow. The purpose of the method is:

- To visualize the current processes where the material is not directly visible.
- To analyze the job flow.
- To identify the problem and find wastes by checking the facts through the eyes of all members.
- To increase the value in the analyzed business process by designing a future state map after solving identified problems/issues.
- To develop a powerful competence of human resources, focusing on value-added activities.

One part of this thesis is to map the procedures and processes connected to the packaging products to help visualize the flow. An analysis and problem identification will also be conducted to help find problematic areas and waste in the value flow. This will be the foundation for further work with the flow and the future state map, that will be the groundwork for Volvo's further work with this case.

In this thesis the current state map will show the supplier of packaging products, the processes, the end user and the information flow. Connected to the current state map will be a more detailed description of all parts of the map that will explain both the physical flow as well as the information flow.

In the analysis of the mapping, possible problem areas will be identified for each process. The reasons for the problems will be investigated and potential alternatives will in some cases be presented.

2.2 Packaging

In this section the Packaging products, Types of packaging and Packaging functions are presented. The purpose of this section is to get a better understanding of the different packaging types, functions and material that are analyzed in this thesis.

2.2.1 Packaging products

This section will introduce the different kind of materials used for packaging connected to this thesis. This will include general information about the material and its qualities as well as the material's benefits and disadvantages in the perspective of its function as a package. The type of materials that will be reviewed are wood, corrugated board and plastic.

2.2.1.1 Wood

Paine (1990) describes wood as resistant to damage by crushing, stretching, bending and twisting. He also mentions that wood can yield temporarily and afterwards go back to its previous state. Wood has for a long period of time been used to make boxes. There are several types of wood, even though not all are suitable for packaging and some of those which are fitting may be too expensive. One of the benefits of using wood as a packaging product according to Paine (1990) is that wood is generally readily accessible as a domestic raw material. He also mentions that the ratio of cost/strength is favourable compared to other packaging products. Some disadvantages that are brought to light by Paine (1990) are that customers are less willing to work with wooden packages and that the ratio of cost/weight as well as shipping space required are unfavourable. He also remarks that the use of wooden packages demand good technical knowledge for the usage to be effective.

2.2.1.2 Corrugated Board

The corrugated board consists of two outside papers known as liners, and between these liners there is a corrugated paper known as fluting or medium (Dekker, 2013). The liners in combination with the fluting makes up one layer. Watkins (2012), mentions some configurations by varying the layers used in the board. The single-wall board made of one layer is the most common type used as a standard for most products. If the products are bigger and/or heavier, a double-wall board consisting of two layers can be used. Adding one more layer, making a triple-wall board, enables the board being used as a substitute for wooden containers for pallet boxes. Because of the big difference in board qualities between the light single-wall board and the heavyweight triple-wall board, there is a great variety of designs and sizes of the packaging available (Dekker, 2013). According to Watkins (2012), the mostly used secondary packaging is corrugated board. Dekker (2013) describes the material as light and high-performance with a structure comparable with materials used in industries such as aerospace, automotive and construction. One disadvantage of corrugated board is that moisture affects the material's mechanical properties; increased moisture reduces compression strength (Watkins, 2012).

2.2.1.3 Plastic

The word plastic comes from the Greek word plastikos, which means to form (Paine, 1990). The ability to be formed is a result of the molecular structure of plastics. According to Riley (2012), many polymers in the packaging industry are based on a common carbon backbone. The chemistry behind choosing the right polymer is quite advanced, and there are a lot of factors that affect the performance of the polymer (Riley, 2012). Therefore, there are a lot of different

variations of plastics and the usage of plastics in packaging is widespread. Emblem (2012) states that in comparison with other packaging products, plastics are generally lighter in weight, more easily shaped and extremely versatile.

2.2.2 Packaging functions

The fact that the packaging does not alter the produced product in any way makes it easy to think of it as a non value-adding activity. Baudin (2004) has made a list of reasons to why that is not the case. The list of the benefits of packaging is as follows:

- Protecting the product against a number of surrounding circumstances. One of the most obvious might be mechanical damage when the product is for example being loaded, transported, unloaded or stored. Other examples are corrosion, contamination, dust, heat, light and theft.
- Protecting the environment from products that are hazardous, for example radioactive or chemical products.
- Preventing the handlers from hurting themselves on the product if the product has, for example, sharp edges.
- Assuring customers that the product is new and untouched, and thereby increasing the product's appeal on store shelves.
- Making the handling of industrial goods more convenient.
- Communicating information about the product.
- Limiting inventory, by having a fixed number of packages in circulation the amount of inventory of the item in those packages is limited to their content.

Goldsby and Martichenko (2005) also argues for the importance of packaging. They mean that the packaging is the fundamental base for analysis in the logistics system. Goldsby and Martichenko (2005) also state that packaging both influences and is influenced by the logistics and manufacturing processes. They also mention that the packaging not only affects, and is affected by, the company, but also other parts of the value chain such as the supplier and the customer.

One aspect that should be taken into consideration according to Goldsby and Martichenko (2005) is the dimensions and holding capacity of the packaging. They argue that a well-thought packaging design can lead to improved handling efficiency, weight and space utilization in a vehicle and an efficient use of warehouse space. The question of ergonomics is also raised by Goldsby and Martichenko (2005). They state that the ergonomics of using the packaging is important to take into consideration for the packaging design as well. Factors that should be recognized are for example how ease the packaging is to handle, if the packaging is safe to handle, how many people is needed to use the packaging and how to dispose of the packaging.

2.2.3 Types of packaging

In this section, the different packaging types that are used in this thesis are presented. The packaging types can be divided into different categories. To explain the different categories, the types are divided into primary packaging, secondary packaging and tertiary packaging.

Thereafter, a distinction between returnable packaging and disposable packaging is presented regarding general information and which activities that are necessary for the usage of the returnable and disposable packaging.

2.2.3.1 Primary, secondary, tertiary

Emblen (2012) writes that the packaging can be divided into three different functions: primary packaging, secondary packaging and tertiary packaging. Furthermore, the primary packaging is the packaging which have direct contact with the product. The authors write that the secondary packaging holds multiple primary packagings together. In this thesis a secondary packaging holds several primary packagings, which in turn holds the spare parts that are needed for one repair. The tertiary packaging is the packaging that store the primary- and secondary packaging during transport (Emblen, 2012).

2.2.3.2 Returnable and disposable packaging

The case in this thesis includes both disposable and returnable packaging. Disposable packaging is only used once and then disposed of, contrary to returnable packaging that is designed for multiple use (Goldsby & Martichenko, 2005). There are pros and cons with both packaging types that will now be presented. Baudin (2004) states that disposable packaging has the advantage that is requires less attention than returnable packaging. For example, no return flow needs to be implemented which means that there is no need for: sorting out the returned packaging, a collaboration with the customer regarding the return arrangements, transportation between and within plants, storage for used, empty packaging or a system to control the circulation flow.

On the other hand, there are some other activities that is added when using disposable packaging. Baudin (2004) states that the number of transactions increases compared with returnable packaging. He also mentions that the disposable packaging comes in a batch of material that needs to be unpacked and then be transported to the storage and built up when needed. This procedure occurs in a repetitive cycle, more frequently in comparison to the returnable packaging. Baudin (2004) also comments that the use of disposable packaging leads to that the customer has to handle the disposal of the packaging, which in some cases require heavy equipment and then has to be transported to either landfills or recycling plants. According to Goldsby and Martichenko (2005), the one-time usage of disposable packaging contributes to a negative environmental impact.

The returnable packaging requires, according to previous reasoning, fewer transactions, less frequent process of unpacking, transporting and building new material and no waste management for the customer. It is also more environmental-friendly. Another advantage of using returnable packaging according to Baudin (2004), is that it can be used to control the manufacturing process and prevent overproduction. Because there is a finite supply of packaging, the products transported in the packaging cannot exceed what fits the containers. Since disposable packaging does not limit the amount of inventory in circulation, the benefit of preventing overproduction does not apply. Baudin (2004) also mentions that disposable packaging can be seen as a resource of unlimited supply and can thereby also be treated as one. A considerable disadvantage of

returnable packaging is the need of a return flow. A return flow includes, as previously mentioned; sorting, storing and transportation (Baudin, 2004). Baudin (2004) claims that the key for lean transportation in the return flow is so called milk runs, where the truck pickup parts from multiple parties in one run instead of going back and forth to and from each one of the parties. Milk runs enable the empty packaging to take advantage of the transport that would otherwise travel the same route empty.

Another aspect of returnable and disposable packaging is the cost. Returnable containers tend to have a more expensive purchasing price than the disposable packaging. However, because the returnable packaging can be used more than once, the cost is distributed over the number of times used. For example, if the price of a disposable packaging is 10 SEK and the price of a returnable packaging is 60 SEK, the returnable packaging needs to be used six times (60/10=6) to be equally costly as the disposable packaging per time used. If the returnable packaging is used more times, it will become cheaper per use than the disposable packaging. Thereby, the number of times a packaging can be reused is important. Baudin (2004) states that the frequency of use is important as well. The process of calculating the period of time that is required for the returnable to become as costly as the disposable packaging is called payback period (Baudin, 2004). If we take the example from before, the payback period of the returnable packaging that costs 60 SEK is half a year if the packaging is used once a month. If the packaging is used daily the payback period is six days. However, this cannot be used as the single foundation to determine the most favorable packaging from an economical perspective. Baudin (2007) remarks that changing to returnable packaging eliminates some activities but adds others, and there is no way of determining which will be the cheapest packaging in all cases. Despite this, Baudin (2007) claims that the added operational costs for the returnable packaging are small in relation to the cost of the packaging itself.

2.3 Pareto principle

The pareto principle, also called the 80/20 rule, is named after Vilfredo Pareto who observed the population in Italy and found that 80 % of the land was owned by 20 % of the population (Chandler & Munday, 2011). The principle states that, in some cases, roughly 80 % of the effects are generated from 20 % of the causes. This principle can be used to see how to use resources more efficiently.

3 METHOD

This chapter will present the methodology that is used for answering the questions from the problem definition. The research strategies, how the data collection gathering was done and the methods that were used are described. The chapter is divided into the sections literature study, empirical study, mapping and validity.

3.1 Literature study

Relevant literature will be the foundation for the theoretical framework. The literature will be focused on lean manufacturing and information about packaging. The part about lean manufacturing focuses on standardized tasks, waste and mapping. The information about packaging is focused on different materials used for packaging, the packaging's functions and different types of packaging. For finding literature, the Chalmers Library's search engine Summon has been used as a starting point. Books24x7 and Google Scholar have been used as well. Information about Volvo and Volvo's way of working will be gathered from the intranet at Volvo.

3.2 Empirical study

The gathering of empirical data will be conducted in the form of interviews and observations. These methods will be presented in the following sections and put into context for the thesis.

3.2.1 Interviews

To be able to understand the current situation, an empirical study will be conducted. To get knowledge about the LDC concept, interviews will be held with operators at the CDC and LDC in Gothenburg. The purpose of these interviews is to give an overview of the concept of LDC's as well as the interviewee's personal opinion of the current situation, before visiting the LDC in Maastricht and conducting interviews there. The aim of the interviews in Maastricht is to give a better understanding of the current situation and highlight the opinions of the operators that actually are working with the distribution system.

The interviews will be of semi-structured nature. Wilson (2014) describes semi-structured interviews as a combination of predefined questions with an open-ended exploration. He also discusses strengths and weaknesses with the method:

Example of strengths:

- Can expose previously unknown facts.
- Ensure that the main points are covered with each interviewee and at the same time. allowing to bring up additional concerns and issues.
- Gives the interviewer flexibility.

Example of weaknesses:

- The interviewer can unwillingly guide the interviewee into a particular answer.
- The mixture of quantitative and qualitative data can make analysis time-consuming to conduct.
- Too much flexibility among interviewers can make the comparisons of interviews more difficult, whereas consistency among interviewers is required.

With these aspects in mind, topic and questions have been predetermined for the interviews. Then the interviewee has been encouraged to speak freely about the subject and give their personal view. Afterwards, the interviews have been summarized and sent back to the interviewee in question so that he or she can validate that what has been perceived by the interviewer is what was intended by the interviewee. If the interviewee do not confirm, a complementary interview will be held.

3.2.2 Observations

Observations will take place at the CDC in Gothenburg, at the LDC in Maastricht and at a connected dealer. The observations will be one of the main bases of understanding the current situation. The observations at the CDC in Gothenburg are the base for understanding the LDC concept, both in Sweden and in Maastricht. The observations at the LDC in Maastricht are the base for this thesis and the base for the current situation.

The observations will focus on different types of packaging, procedures and processes connected to the flow of packaging - both physical and information flow.

3.3 Mapping

The mapping of the current situation consists of a value flow work of the packaging products in the LDC in Maastricht. The way of working is based on Volvo's own working procedure concerning value flows. The result will be a current state map showing how the packaging products are delivered to the LDC, the different processes at the LDC and how the packaging products are distributed, both concerning physical and information flow. The mapping is based on observations, explained in section 3.2.2 Observations, as well as interviews, explained in section 3.2.1 Interviews. Further information about the method of mapping is presented in section 2.1.4 Mapping.

3.4 Validity

How well research findings match reality is called validity (Merriam, 2009). Merriam (2009) mentions a method to increase the validity that is called triangulation. Triangulation is a method to cross-check research. Thurmond (2001) describes five types of triangulation as follows:

Data sources triangulation is the combination of using data collected at different times, places or from different people and comparing these findings to strengthen credibility. This can for

example be done by observing over a period of time or at different places, or by interviewing people with various perspectives or follow-up interviews.

Investigator triangulation refers to using multiple people collecting data (e.g. observers, interviewers, data analysts) in the study. If the collection of data is done independently between investigators and the findings corroborate, the credibility increases.

Methodologic triangulation occurs when using various methods to collect data within the study, for example interviews, observations and documented information. This can be implemented by using the within-method or the between- or across-method. The within-method employs multiple data-collection procedures from one design approach, either quantitative or qualitative procedures.

The between- or across-method combines both qualitative and quantitative methods in the same study.

Theoretical triangulation appears when multiple theories or hypotheses are used in the study. This approach enables investigating the study from several perspectives and with multiple questions in mind.

Data-analysis triangulation means to analyze the data using at least two different methods.

Benefits of triangulation can be a greater confidence in research data, challenging theories and a clearer understanding for the problem (Thurmond, 2001). Disadvantages of the method include that it is time-consuming compared to single strategies, difficulty handling the large amount of data and conflicts because of theoretical framework (Thurmond, 2001).

In this study, data sources triangulation and methodological triangulation will be used. The data sources triangulation will include collecting data from several operators and then following up these interviews by contacting the interviewees by e-mail afterwards. This feedback will validate that the data from the interviews were accurately perceived. The operators will be working at different positions and at different places, both the CDC in Gothenburg and the LDC in Maastricht, that will contribute to their different perspectives. Interviews will be conducted during the six months the study is ongoing. Observations at the LDC in Maastricht will be made during two consecutive days. This limits the validity of the study because it is difficult to know whether or not these observations represent a state that is typical. This will be handled by asking the operators working at the center if they recognize the observed state as representative. The methodologic triangulation consists of using interviews, observations, literature and documents as a base for collecting data. Comparing the data gathered from these methods will increase the validity of the thesis.

4 EMPIRICAL FINDINGS

This chapter will present the data that has been gathered regarding the LDC concept. The chapter is divided into the LDC concept, Current state map, Packaging procedures and Usage of packaging products. The LDC concept will give an overview of how the LDC's work in general. The rest of the chapter is focused on Maastricht and will investigate the packaging products' flow, processes and costs.

4.1 The LDC concept

This section consists of a summary regarding the LDC concept, to give an overview of the concept. The section is divided into General information and The LDC in Maastricht. The section about general information is based on data gathering from operators in Sweden and the section about the LDC in Maastricht is based on data gathering from operators from Sweden and Maastricht.

4.1.1 General information

To get a better understanding of the LDC concept, a brief summary regarding the process of what happens from the ESC in Sweden, Gothenburg, to different LDC's in Europe will be presented. This process can differ in some cases regarding different processes of the information and physical flow, but, overall, this summary explains the process and will give a short introduction to understanding the process of what happens before the goods arrive at the LDC, which in this thesis is the LDC in Maastricht.

The first step in the procedure is that the dealer gets a customer with a car that needs to be repaired. The employees at the dealer decide which products that are required to repair the car. Thereafter, the employee sends an order to a LDC. The employee at the dealer decides which classification the order will be given, depending on how fast the car needs to be fixed. The classification system is as follows:

- Class 0 - V.O.R (vehicle off road), is the highest prioritized order class and is only to be used in emergencies.
- Class 1 - This transport goes daily to cover unplanned repairs.
- Class 3 - Special orders. Pre-planned and late pre-planned. Pre-packed order for a repair.
- Class 4 - Stock filling at the dealers for high frequent parts.

The LDC ensures that the orders are transported to the dealers in time. This will be further explained in detail in the current state description. The LDC has a storage for spare parts, and the ESC is responsible to fill it, this is explained further in the next section.
Operators at the ESC will be notified by a computer system, from here on referred to as web-PULS, when a packaging product at a LDC needs to be refilled. This system will only work if the

inventory of the packaging product is updated in web-PULS. The notification will then be sent to the ESC when a certain refill point is reached for the packaging product. When it is time for the refill-order to be packed, an operator retrieves the spare parts in the CDC's storage. Once the spare parts are gathered, the next step is to pack the spare parts in a secondary packaging. The order in the secondary packaging is then, in most cases, put into a tertiary packaging. The operator decides which tertiary packaging that will be used concerning material and volume for the packing of the orders. The packaging procedure is manual and the operators build the tertiary packaging by hand or with help from different tools. There are many different tertiary packaging types that can be used. A tertiary packaging can consist of different materials and a various number of parts. When the tertiary packaging is built and filled with secondary packaging, it is sent to a loading area in the CDC before it is transported to different LDC's in Europe.

The operators pick up the goods and load it on a truck. After the goods are loaded on the truck, the goods are secured and tightened with lashing. This routine is to keep the goods steady during transport. When the truck is filled and secured, the transportation to LDC's in Europe takes place.

The truck carries goods that will be unloaded at different LDC's in Europe. Some trucks only carry goods that will be left in one LDC and some trucks hold goods that will be dropped in more than one LDC. After this step, the LDC's receive the transported goods and unload it at the LDC. From this step the process can differ between different LDC in Europe. This thesis will focus on the processes at the LDC in Maastricht, and therefore this process will be explained further in section 4.2 Current state map.

A wide variation of products come back in a return flow. In the beginning the operators were throwing all the packaging products from the return flow, because the used packaging was coming back unsorted and there were a lot of different products types and they were returned in a bad condition. The bad condition can be a consequence of bad handling at the dealer, bad handling at the loading and unloading as well as the transport. However, this process has become better during the last couple of months. The reasons are that the dealers have now gotten a manual, with information about how to send back the used packaging products, and the product types have decreased.

However, there is no working process regarding the information flow for the return flow to the CDC in Sweden. The process consists of manual work of which packaging products that come back on a handwritten list. There is no working communication between the list and purchase of packaging products. A reason is because there is a wide variation of the packaging products in the return flow.

4.1.2 The LDC in Maastricht

The LDC in Maastricht provides the dealers in the adjacent area with spare parts. The dealers cannot be further away than two hours driving distance of the distribution center, or they will not be assigned to the LDC in Maastricht. There are three deliveries a day distributing spare parts to the Maastricht area; two day deliveries and one night delivery. The Maastricht plant is not only a

LDC, it is also a SDC. The SDC supports areas that do not have a LDC, and the SDC in Maastricht distributes spare parts to the dealers in France.

The LDC in Maastricht was until mid-year 2015 operated by Volvo. After this point, a third-party logistic took over the LDC. With the change of ownership there was a few differences in the way of working with the packaging. One of the main changes was the change in the ordering process. Before, the LDC ordered packaging products from both the ESC and Papyrus. After the change, they stopped ordering from Papyrus. The last invoice from Papyrus is in August 2015.

4.2 Current state map

This section will present the different current state maps and explain the steps and processes in the LDC in Maastricht. The maps are divided into three different flows: day delivery, night delivery and delivery to France. The different flows have been mapped during this thesis and are visualized in the appendices. In appendix 10.1, the Current state map: Day, appendix 10.2 Current state map: Night and the Current state map: France, can be seen.

The current state maps consist of the same processes from the process step receiving until the process step packing orders, and the explaining sections for the maps will be the same for all maps up to this point. After this process step, the explanation is divided into three flows corresponding to the three different maps. The process at the supplier, External Stock Control (ESC), is the same in all maps, as well as the end customer, the dealer. In the map for delivery to France, there is an alternation in the end of the map, where the transported goods are delivered to a hub before being distributed to the dealers.

Lastly, the return flow is described. This section is also divided into different flows: Returns from LDC dealers and Returns from France.

4.2.1 External Stock Control (ESC)

The ESC is situated in the CDC in Sweden, Gothenburg. They are responsible for refilling the distribution centers with spare parts and packaging products.

Physical flow: The ESC refills the LDC's inventory when needed by sending a truck with the required goods. Three trucks a day are delivering spare parts and packaging products to the LDC in Maastricht.

Information flow: For all the packaging products, the operators at the LDC will manually observe the current stock of packaging products and send an email to the ESC when more packaging products are needed. If the inventory in web-PULS is not updated, the ESC ask the operators at the LDC to update the inventory by email. This updating of inventory is not a continuous process, but happens occasionally. The ESC then decides what quantity that should be sent and when the products should be received. The reason for the manual handling of the

information flow regarding packaging products is because some of the packaging products are reusable. This is further explained in the segment about the return flow.

4.2.2 Receiving

Physical flow: Trucks from Sweden arrive three times per day to the LDC. The trucks are filled with a combination of refill products and referrals to be cross-docked. The spare parts are packed in Volvo packaging and the packaging products are placed on pallets. An example of spare parts being unloaded is found in figure 1 and packaging products still in the truck can be found in figure 2. Forklifts unload the truck.

Figure 1: Trucks from Sweden being unloaded.

Figure 2: Trucks from Sweden being unloaded.

Information flow: The trucks arrive at appointed times during the day. Checking of the goods occur in the next process.

4.2.3 Goods reception

Physical flow: The goods from the truck are moved inside by a forklift to an unloading area, as can be seen in figure 3.

Information flow: In the unloading area, the goods are inspected to ensure that the shipment is correct. The inspection is made by looking at an order list attached to the goods and comparing it to the physical items.

Figure 3: Different tertiary packaging types that are stacked on each other in the unloading area *from Sweden and France. The picture visualizes a packaging box that is collapsed, probably due to the weights on top of it.*

4.2.4 Inventory: Storage

Physical flow: After the goods are inspected, they are moved to a storage location by a forklift. Each packaging product has a designated primary location for storing. If this place is full, the LDC has a buffer storage to place packaging products that do not fit into their designated storage location.

The secondary and tertiary packaging are stored at the LDC in different locations. The secondary packagings, for example plastic bags, Blue boxes and Cardboard boxes, are stored on the racks in the LDC together with the spare parts. The tertiary packagings, the One Way and HD packaging, are stored and built at the same place. At this location they have a big space for building up the packagings. Figure 4 and figure 5 show these storage locations.

Figure 4: Storage area for secondary packaging.

Figure 5: Storage area for tertiary packaging.

Information flow: The designated primary storage location can be found on the inspection list from the previous process. If the designated location is full, the buffer storage is used.

4.2.5 Inventory: Packing Area

Physical flow: At the LDC there is an area for packing orders. This is called the packing area and consists of working stations for the operators working with picking and packing orders, from here on referred to as operators. The packing area also consists of built up tertiary packagings and a small storage of packaging products for secondary packaging. Every morning the storage of secondary packaging close to the workstations is refilled, so that they have packaging products for the whole day. The operators also ensure that there are built up tertiary boxes to be used

throughout the day. If there are not enough built up boxes, the operators have to build new ones. The building process takes place close to the storage area for tertiary packaging, as can be seen in figure 6.

Figure 6: Building area for tertiary packaging, both for new One Way boxes, HD boxes and boxes that are reused.

Information flow: When refilling the secondary and tertiary packaging for the packing area, the operators observe and decide if the packaging products need to be refilled and/or built up. This decision is based on the operator's experience.

4.2.6 Packing orders

Physical flow: The operators receive orders from the dealers via web-PULS. One order can for example be all spare parts that is needed for one repair or parts that is needed to be refilled in the dealer's own stock. One order consists of several order lines, and one order line is one type of spare part. There can be more than one spare part in one order line.

The operators then print a list of order lines and pick the spare parts with a truck. Most of the orders need to be packed in a separate secondary packaging. Exceptional cases are when the product is big and will not fit into the tertiary packaging. Labels are attached to the secondary packaging, or the product's primary packaging if it does not have a secondary packaging, and the order is double checked before continuing to the next process.

Information flow: The operators can see the different orders from the dealers in web-PULS. The orders can be of different classes depending on urgency, this determines in which order they should be picked. The selection process of what secondary packaging to be used is described in the section about secondary packaging. After picking a secondary packaging for the order, the operators fill in which packaging type they have used in web-PULS and then print out a case label, which the operator place on the packaging. On the label there is information about the

order, the order's destination and which packaging that has been used. Furthermore, some of the orders can be packed in more than one secondary packaging, if this is the case, all of the secondary packagings that are used for one order need a label with information about the content. If the order contains dangerous or fragile goods, an additional information label have to be added. When labeling the secondary packaging, it is important for the operators to put the new label over any existing labels so that there are no misunderstandings of what order is in the packaging. The information regarding what packaging type that has been chosen is only used for the label that is printed out and not used to change the inventory for the packaging product in web-PULS.

4.2.7 Delivery Area

The next process is to prepare the orders for being picked up for transportation. Depending on when and to where the orders are sent, there are three different flows. The flows are divided into day deliveries, night deliveries and deliveries to France. The reason is because the day and night deliveries are distributed directly to dealers within a two-hour driving radius from the LDC in Maastricht, and the France deliveries are transported a longer distance and are delivered first to a hub and then repacked and transported to the dealers in France. These three different flows will be described further as follows. The process of choosing packaging type is further described in section 4.3 Packaging procedures.

4.2.7.1 Day deliveries

Physical flow: Day deliveries occur two times a day. The packed orders are placed in a wire cage which is rolled out when it is time for transportation, see figure 7. One separate wire cage is used for each dealer and the wire cage's functions is to transport the orders from the operator's station to the van. The orders are moved by the operators from the wire cage into a van, without any further packaging than its primary or secondary packaging. The orders are put directly on the floor. Each van is dedicated, which means that there are no other products than Volvo products transported in the van, and transport orders to several dealers.

Figure 7: Orders for day deliveries packed in a wire cage ready for transport.

Information flow: The class 1 orders are distributed by the day delivery. Each wire cage is designated to a specific dealer, and the drivers of the vans know which dealers that are in their route. The drivers have a list of the orders and check manually that everything is correct before putting the orders in their van, which can be seen in figure 8. The degree of filling varies depending on days and routes.

Figure 8: Drivers of the vans checking the daily orders before loading them in the van.

4.2.7.2 Night delivery

Physical flow: The orders with class 1, 2, 3 and 4 are distributed by the night delivery with a truck. If the order is not too big, it is put in a tertiary packaging, see figure 9. If the product is too big, it is placed beside the tertiary packagings. The tertiary packaging for the night deliveries is a HD box, which always is of the same size and consists of a pallet of wood and four wooden collars. This is further described in the section 4.3.2.2 Tertiary packaging. If the box is full and there are more orders that have to go to the same dealer, the operators do not put on an extra collar on the box, instead they take a new box to continue filling. This leads to that some of the boxes are not fully filled, when delivered to a dealer. The boxes filled with orders and the orders that are too big for a box are collected by the truck drivers and are placed in the truck, early in the morning, and are distributed out to the dealers. The HD boxes are only loaded in one single layer inside the truck, because there are no tools for handling stacked boxes at the dealer.

Figure 9: Night orders in a HD box.

Information flow: Each HD box is designated to a specific dealer, and the drivers of the truck know which dealers that are in their route. The drivers have lists of the orders and check manually that everything is correct before putting the orders in their truck.

4.2.7.3 Delivery to France

Physical flow: Like the night deliveries, the orders to France are put in a tertiary packaging if it is possible. The tertiary packaging that are used for France delivery is the One Way boxes, which is presented in the section 4.3.2.2 Tertiary packaging. If the box or boxes are full and there are more orders that have to go to the same dealer, the operators do not take a new box and start to fill in, instead they take a smaller packaging that fits the order and put it beside the tertiary packaging in the transport. The One Way boxes and the associated orders are placed in a truck that goes to a hub in France for further distribution.

Information flow: The operators load the goods in the truck and check manually that everything is correct.

4.2.8 Dealer

Physical flow: At the dealer the driver unloads the goods and leave it in the dealer's workshop. The employees at the workshop open the tertiary packaging and pick up the secondary packaging that holds an order. They then stock the orders in a shelf that is placed in the workshop. When the order is needed to repair a car, an employee unpacks the secondary packaging, takes out the order and then folds the secondary packaging and puts it in a HD box that has been emptied of orders. The same procedure happens with the rest of the secondary packagings. When the employees at the dealer put the empty secondary packaging in the HD boxes, they do not sort them. When the HD box holds enough secondary packaging, the night delivery picks it up together with other returns back to the LDC, in a so called milk run as mentioned in the theoretical framework.

Information flow: When receiving the goods, the employees at the dealer checks the orders to confirm that everything is correct. If there is anything inaccurate with the shipment, the dealer will contact the LDC.

4.2.9 Hub

Physical flow: The goods to France are transported to a hub where the orders are reloaded for distribution to dealers. The hub is a distribution center where the goods are stocked before going out different dealers.

Information flow: This thesis will not further explain this process, because it is not a part of the scope.

4.2.10 Return flow

When the dealers have received the orders, some of the used packaging products are sent back to the LDC in a return flow, together with other returns. There is no formal system for the returns of packaging products, so the returns of packaging products may vary. There are also different returns depending on where the returns come from. The return flow consists of two different physical streams: returns from LDC dealers and returns from France, which will be explained in the following sections.

4.2.10.1 Returns from LDC dealers

Physical flow: When the truck driver has unloaded the goods for the night delivery, the driver picks up the used packaging that is returnable and the returns. The returns can for example be damaged spare parts or spare parts that the dealer did not need. The transport of the goods goes back to the LDC. At the LDC the goods are unloaded. Mostly, the returns of packaging products consist of Blue boxes and HD boxes.

The secondary packaging which can be reused are mostly Blue boxes. These are not sorted when arriving. Consequently, operators at the LDC need to sort out the different types of blue boxes before storing them. Damaged boxes are thrown away. When the boxes are sorted, the used blue boxes are stored outside, mostly in used HD boxes as can be seen in figure 10 and figure 11.

The tertiary packaging that can be reused is placed in the LDC and the tertiary packaging that can not be reused is thrown away in a garbage container, as can be seen in figure 12. In this case, the tertiary packaging that can be reused is the HD boxes, which normally still are built up and not collapsed when returned.

Information flow: When packaging products return to the LDC, they are not counted and put into web-PULS, which leads to that the inventory in web-PULS is not updated. The reason for this, is because the operators at the LDC think that it would be too time consuming. There are

also no formal routines between the dealers and the LDC for returns of packaging products, so it can not be assumed that the same quantity of packaging that is sent out is received back.

Figure 10: Storage of used Blue boxes in HD boxes.

Figure 11: Sorted Blue boxes in a HD box. One HD box holds one group of Blue boxes.

Figure 12: A picture from the containers where the packaging products are thrown away. In this picture pallets are stacked on each other, the pallets can be reused. But, this pallets are not used at the LDC in and are therefore discarded.

4.2.10.2 Returns from France delivery

Physical flow: There are also returns coming from the hub in France, examples can be seen in figure 13 and figure 14. The returns of spare parts are similar to the ones from the night deliveries and these will be transported to the LDC in Maastricht and then directly to the CDC in Sweden without being repacked. The returning packaging products can be a mix of Blue boxes, Cardboard boxes and One Way cardboard boxes. The Blue boxes are sorted out in the same way as with the night deliveries. The cardboard boxes, both small Cardboard boxes and One Way, are reused if possible, which means if they are not damaged or if the LDC has any use for them. As the LDC mostly uses one size of the wooden HD boxes and one size of the One Way boxes, many other sizes of boxes are thrown away.

Information flow: When packaging products return to the LDC it is not counted and put into web-PULS, which leads to that the quantity in web-PULS is not updated. The reason for this, is because the operators at the LDC think that it would be too time consuming. There is also no formal developed system between the dealers and the LDC for returns of packaging products, so it can not be assumed that the same quantity of packaging that is sent out is received back.

Figure 13: Returns from France. This is a Cardboard box that is damaged.

Figure 14: Returns flow from France. This is a cardboard box which is damaged, to get the box stable a provisional solution has been made.

4.3 Packaging procedures

In this section the Packaging process and the different Packaging types will be presented. The Packaging process will present routines and guidelines of the way of working and how the learning and start-up process work. The section about Packaging types will consist of two subgroups, secondary packaging and tertiary packaging and present information about different packaging types within each category.

This information is based on interviews, observations and the operators' opinions.

4.3.1 Packaging process

Operators are taught the packaging process in the beginning of their employment as operators at the LDC. The learning phase consists of reading guidelines/manuals for how the packing procedure should be done, observing an operator with experience and learning-by-doing with observations from the teacher. The guidelines consist of explanations about the working process, the observing consists of an operator who teaches them the process and learning-by-doing consist of testing the working process with help and observations from the operators who teach. When the start-up learning process is over, the operators develop their own way of working. There are also guidelines on how to handle dangerous goods. Some rules are also learned in the start-up process, for example just handling one order at time, to prevent mix up and to increase the quality.

4.3.2 Packaging types

In the first section, the working process of the secondary packaging will be presented regarding which packaging that is used and the reasons why. Furthermore, the different secondary packaging types that are used in Maastricht will be presented regarding general information, positive attributes, negative factors and why the operators choose to use the particular packaging; usage. A table with the different types of packaging products will also be included. The table will show size, cost and how the packaging products was discovered. How the packaging products were discovered is presented in the last column, it can be done either by observation, which means that the packaging type was seen in connection with the visit, or by order history, this data can be found in appendix 10.5 Order history: ESC.

4.3.2.1 Secondary packaging

The secondary packaging consists of Blue boxes, Cardboard boxes and plastic bags. Every different packaging product consists of a group of different sizes and shapes. The secondary packaging is most commonly used to hold one order. The operators choose a packaging by using experience, they observe the order's content, volume and shape, and then decide which packaging to be used. If the operator for example chooses a packaging that is too small or too large for the order, the operator repacks the order in another secondary packaging. When the operators have picked and packed an order, they fill in which packaging they have used in a computer system, which is not connected to web-PULS. After that, the operator prints a label with the information and places the label on the packaging. If an order consists of dangerous

products, the operators also place a label with information about dangerous goods. There is no reporting to the information flow regarding which and what quantity of secondary packaging that is used for the orders that are put into web-PULS.

The different secondary packaging types will now be presented in the sections below.

Blue boxes

The Blue boxes are visualized in figure 15 and 16. Furthermore, the different types of Blue boxes are presented in table 1.

General information

- The material of the boxes is plastic.
- Are the most commonly used secondary packaging.
- The Blue boxes are ordered from the ESC in Sweden.
  - Before ordering, the inventory is observed manually and then the operator decides the number of packaging products that should be ordered.
  - Are ordered if necessary, but because of the return flow the boxes is reused and therefore do not need to be refilled very often.

Product	Product number	Size [mm]	Cost [SEK]	Observed/ Order History
Blue box, extra large	6769001	850x300x255	52,06	Order History
Blue box, large	6764449	500x300x166	34,18	Observed
Blue box, medium	514334	368x249x166	27,22	Observed and Order History
Blue box, small	6769004	120x120x230	19,14	Observed

Table 1: The different types of Blue boxes

Positive attributes

- The Blue boxes can be reused. A common belief from the operators is that the boxes can be reused a number from 4 to 25 times. After a couple of reused times the boxes can be for example, damaged, spilled with oil or covered with labels, and have to be thrown away.
- The operators think the handling (except when the box is new) is easy and the general attitude against the Blue boxes is positive.
- The employees at the dealer think that this product is easy to handle, because:
  - It is easy to unpack the order from this packaging.
  - It can be reused and therefore the employees do not have to throw it away in the garbage. Instead they send the used boxes back to the LDC.

Negative factors

- A general opinion from the operators is that the plastic is stiff to fold the first one-two times, after two times they become more soft and are easier to build.
- A common belief of the operators is that the Blue boxes can sometimes be unstable after being reused a couple of times.
- When reusing a used box all different types come back to the LDC unsorted. The sorting process takes time.
- No data regarding the number of boxes in circulation, which has led to a large inventory because of the lack of control of the flow.
- The operators cannot place dangerous labels on the Blue boxes, because labels on the Blue boxes are hard to remove.

Usage

Are used when/because:

- There are no special attributes to the order. The boxes are the operators' primary choice for packaging. Examples of the special attributes that require another type of packaging will be presented in the sections about Cardboard boxes and plastic bags.
- The volume of the order fits in one of the boxes' sizes.
- The operators think that the Blue boxes are the cheapest secondary packaging, and try to use it therefore.
- The operators think it is good for the environment to reuse the packaging, and therefore use the Blue boxes.
- The operators use the Blue boxes because they think it is easy to use and handle the boxes.

Figure 15: Different types of Blue boxes at the operators' station/work area.

Figure 16: Blue boxes.

Cardboard boxes

The Cardboard boxes are visualized in figure 17 and figure 19. Furthermore, the different types of Cardboard boxes are presented in table 2.

The Cardboard boxes are divided in two different types, Cardboard boxes and Cardboard boxes used for big products. In the first section information regarding the Cardboard boxes will be presented, in the second section the Cardboard boxes for the big products will be presented.

General information

- The material is hard paper.
- Are not used often.
- The Cardboard boxes are ordered from the ESC in Sweden.
  - Before ordering, the inventory is observed manually and then the operator decides the number of packaging products that should be ordered.

Product	Product number	Size [mm]	Cost [SEK]	Observed/ Order History
Corrugated Box Brown 0201, with handles	509732	615x145x110	5,12	Observed and Order History
Corrugated Box Brown 0201, with handles	509722	165x165x170	2,52	Observed and Order History
Corrugated Box Brown 0203, with handles	509748	1820x150x700	57,66	Order History
Corrugated Box Brown 0203, with handles	509753	1350x140x230	20,84	Order History
Corrugated Box Brown 0201, with handles	513537	300x230x200	7,32	Order History
Corrugated Box Brown 0201, with handles	513542	615x235x200	13,44	Order History
Corrugated Box Brown 0201	514339	255x150x95	4,38	Order History
Corrugated Box Brown 0201, with handles	540403	300x200x130	3,64	Order History
Corrugated Box Brown 0203, with handles	1152639	515x220x115	16,18	Order History
Corrugated Box Brown 0203, with handles	5925576	1800x400x800	87,6	Order History
Corrugated Box Brown 0203, with handles	6766207	2050x120x320	79,81	Order History

Cardboard box	6766296	185x49x45	105,37	Order History
Cardboard box	6767427	150x34x 8	165	Order History
Cardboard box	6767746	186x54x74	91,39	Order History
Corrugated Box Brown	6768462	366x338x85	12,53	Order History
Cardboard box	6768785	28x 11x99	9,48	Order History

Table 2: The different Cardboard boxes that are used.

Positive attributes

- The cardboard is hard and makes the box stable.
- The cardboard can absorb moisture.
  - Good if there is leakage of dangerous liquids.

Negative factors

- Are not reused. The waste of the cardboard boxes can be seen in figure 18.
- The operators think that the boxes are expensive in relation to the Blue boxes.
- Needs tape to build.
- Takes more time to build than the Blue boxes.
- The employees at the dealer thinks that the handling process is harder, than with the Blue boxes. The reason is because they have to take care of the garbage, that comes with that the Cardboard boxes is not reused.

Usage

Are used when/because:

- The order does not fit into the Blue boxes, for example too big, too small or odd shape.
- The order or part is fragile, heavy or dangerous.
- Goods are transported far away, overseas or by airplane, and are exposed to different climates or when the consumer uses the boxes, for example France or Switzerland.
- There is need to put labels for dangerous goods on it. The cardboard box is not reused and therefore the label will not cause confusion among the operators in different departments and the employees at the dealer.

Figure 17: Different types of Cardboard boxes. The circular shape boxes is used for protection of windscreen wipers.

Figure 18: Different Cardboard boxes which is not reused discarded in a container.

Figure 19: Cardboard boxes

The Cardboard boxes for big products

Overall, the same characteristics apply for the Cardboard boxes for big products as for the other Cardboard boxes. In the packaging area there is a special place for the operators packing the big products. For the big products the operators choose a big size of the Cardboard boxes. To build the Cardboard boxes one person is needed. Furthermore, to build the packaging the operators must use tape and a stapler. The operators choose packaging size by observations and experience. The packaging is not reused.

Plastic bags

The plastic bags are visualized in figure 20 and figure 21. Furthermore, the different types of plastic bags are presented in table 3.

General information

- Nine different sizes are ordered.
- Are made out of soft plastic.
- Not used often.
- The plastic bags are ordered from the ESC in Sweden.
  - Before ordering, the inventory is observed manually and then the operator decides the number of packaging products that should be ordered.

Product	Productnumber	Size [mm]	Cost [SEK]	Observed/ Order History
Plastic Bag	540442	65x300x0,07	0,30	Order History
Plastic Bag Kangaro	6767801	100x150x0,04	0,10	Order History
Plastic Bag Kangaro	6767802	150x250x0,04	0,22	Order History
Plastic Bag Kangaro	6767803	200x300x0,05	0,44	Order History
Plastic Bag Kangaro	6767804	200x500x0,05	0,72	Order History
Plastic Bag Kangaro	6767805	300x350x0,05	0,77	Order History
Plastic Bag Kangaro	6767806	350x500x0,05	1,03	Order History
Plastic Bag Kangaro	6767807	300x1000x0,07	2,53	Order History
Plastic Bag	6767808	500x600x0,07	1,69	Order History

Table 3: The different plastic bags that are used.

Positive attributes

- When packed for delivery they do not fill up extra/empty volume.
- The plastic is transparent and therefore the products in the order can be seen through the plastic.

Negative factors

- Are not reused at the LDC.
- Does not provide as good protection as the other packaging products types.

Usage

Are used when/because:

- The order consists of a few or one product.
- The shape of the product is unusual/does not fit the shape of the boxes.
- The product is not dangerous or fragile.
- To hold small spare parts in a secondary packaging.
  - The plastic bags are not only used as a secondary packaging.

Comments from Sweden

- The plastic bags can be reused.

Figure 20: Plastic bags

Figure 21: Plastic bag

4.3.2.2 Tertiary packaging

The tertiary packaging is the unit which is filled with the secondary packaging. The tertiary packaging consists of two different types, One Way packaging and HD boxes. In the LDC, the One Way packaging is used for delivery to France and the HD boxes are used for deliveries to the dealers in the Maastricht area. There is no reporting to the information flow done by the operators regarding which and how many tertiary packaging that is used for the orders to web-PULS. Before the tertiary packaging is placed in the transport truck, operators check and fill in by hand which tertiary packaging that is used on a label, and to which dealer the packaging should be transported to. Furthermore, the operator places the label on the packaging and after that the tertiary boxes filled with orders are ready to be transported.

The different tertiary packaging types will be presented in the next section.

One Way packaging

The One Way packaging is visualized in figure 22 and figure 23. Furthermore, the different types of One Way boxes are presented in table 4.

General information

- A box consists of:
  - Pallet, made of wood.
  - Outer frame, made of cardboard.
  - Inner frame, made of cardboard
  - Support plank, made of wood. Takes three planks for one box.
  - Lid, made of cardboard.
- The One Way cardboard boxes are in one size, F4. Dimensions can be found table 4.
- Takes two people to build.
  - But in most cases one person can build it.
- Are used for deliveries to France.
- The One Way boxes are ordered from the ESC in Sweden.
  - Before ordering, the inventory is observed manually and then the operator decides the number of packaging products that should be ordered.
- Degree of filling:
  - Are in most cases filled when transported.
  - If the boxes are full and there is some more orders that have to go to the same dealer, the operators do not take a new box and start to fill in, instead they take a smaller packaging that fits the order and put it beside the tertiary packaging in the transport.

Product	Product number	Size [mm]	Cost [SEK]
Wooden Pallet (F) 	6768987	1595x1185x140	118,56
Outer frame (F4) 	6768984	1602x1171x820	151,66
Inner frame(F4)	6769034	1157x791x820	36,15
Support plank (incl. 2 angle irons) *Three planks for one box*	6769036	19x100x1200 (50x50x35x2,5mm)	25,19 * 3 = 75,57
Lid (F) 	6768986	1616x1192x160	55,52
Total cost One Way box size F:			437,46

Table 4: The parts that the One Way box extend of.

Positive attributes

- Big sizes.
  - The operators perceive the One Way boxes to be easier to fill because of their size.
- Light weight.
- Easy to handle.
- The cardboard parts, can be reused approximately two to five times, but in Maastricht they often use it once.
  - Must be carefully handled, to be reused.
- If they are damaged in some way, they cannot be reused.
- If they are collapsed when returned, they are hard to rebuild.
- The wooden parts, the pallet, can be reused approximately three to five times.
  - Must be carefully handled, to be reused.

Negative factors

- Ergonomic aspects:
  - Tools are in some cases needed in the building process.
  - Force and uncomfortable position for the persons who is building it.
  - Consist of different parts, have to build more pieces.
  - Hard to handle, because they are big.
  - The height and width of the box makes it hard for the operators to put orders in it.
    - If the orders are heavy the ergonomic problems increase.
- If the orders are heavy two persons need to carry it, it can therefore be unbearable to put an order in the boxes.
  - If the orders are hard to handle or bulky the ergonomic problems increase.
- The height and width of the box makes it hard for the employees at the dealer to pick up orders.
- If the orders are heavy or ungainly the ergonomic problems increase.
- The procedure of the building consists of many steps and therefore the opinion from the operators are that the One Way packaging is hard to build.
- Are sometimes returned from France, but there is no system for the process.

Comments from Sweden

- The One Way consist of several parts. An operator at the CDC in Sweden, mentioned that it is a cost to have a product in web-PULS.
- They think it is expensive.
- Can collapse during load securing in the truck.
  - A consequence can be that the operators do not secure the goods with the right amount of force, which can lead to security risks.
- Take up much storing place, because they consist of different parts.
- Do not fit in the automatic high-bay warehouse. This stocking place is adapted to the Volvo packaging The consequences of this are not investigated in this thesis.
- The One Way boxes can collapse if:
  - They are exposed to external forces. An example can be seen in figure 24.
  - The climate is damp.
  - They are stacked on top of each other, as can been seen in figure 25.
- Because the One Way packaging is used as a disposable packaging product they are used when there is no return flow.

Usage

Are used when/because

- Orders are sent to France.
  - Wooden boxes, like the HD boxes, are not allowed because there is no working system for returns of used packaging products.

Figure 22: A Cardboard box for transport to France, with lid.

Figure 23: A Cardboard box for transport to France, without lid, and a support plank for stability.

Figure 24: The One way packaging is collapsed due to the tensioned rope.

Figure 25: A One Way box that has collapsed. The reason why can be that the boxes that are stacked on top of it are carry too much weight.

Heavy Duty (HD) packaging

The HD boxes are visualized in figure 26. Furthermore, the different packaging products of HD boxes are presented in table 5.

General information

- The boxes that are used are made of wood and are always in one size, L4. The boxes extend of:
- Pallet, L-size.
- Collars (in Maastricht they always use four collars height, and therefore the name L4).
- Lid.
- Takes two people to build.
  - But in most cases one person can build it.
- The HD boxes are used for transport out to the dealers in the Maastricht area.
- The HD boxes are ordered from the ESC in Sweden.
  - Before ordering, the inventory is observed manually and then the operator decides the number of packaging products that should be ordered.
  - Are ordered if necessary, but because of the return flow the boxes are reused and therefore do not need to be refilled often.
- Degree of filling:
  - A box goes to one dealer, if the box becomes full they start to fill a new box.
  - A common belief among the operators is that the HD boxes are full with secondary packaging approximately 50 %, of the time when they are transported. Furthermore, if a box is full and there is some more orders that have to go to the same dealer, the operators start to fill a new box, this boxes are in most cases not fully filled.
- All parts can be reused, approximately 5-15 times, according to operators in Maastricht.
  - Are always returned from the dealers.
  - Are not collapsed when returned.

Comments from Sweden

- Can be reused 6-7 times according to operators in Sweden.
- Thinks that the employees at the dealer likes these boxes best.
- The HD boxes fit in the stocking places at the high bay in the CDC. The consequence of this is not investigated in this thesis.

Product	Product number	Size [mm]	Cost [SEK]
Lid (L) 	6769142	1220x818x11	58,94
Pallet (L) 	6769140	819x1222	93,38
Collar (L) *4 collars for one box* 	6769141	1222x838	66,15 * 4 = 264,6
Total cost for one HD box of size L4:			416,92

Table 5: The different packaging products of the HD box.

Positive attributes

- A common belief among the operators is that they are easy to build in relation to the One Way packaging.
- The boxes are always returned built up, which the operators believe is beneficial because:
  - It makes the handling easier.
  - They do not have to rebuild the boxes, which saves time.

Negative factors

- Ergonomic aspect:
  - Heavy.
  - The height and width of the box makes it hard for the operators to put orders in it.
    - If the orders are heavy the ergonomic problems increase.
- If the orders are heavy two persons need to carry it, it can therefore be unbearable to put the order in the boxes.
  - If the orders are hard to handle or ungainly the ergonomic problems increase.
  - The height and width of the box makes it hard for the employees at the dealer to pick up orders.
    - If the orders are heavy or ungainly the ergonomic problems increase.

Comments from Sweden

- The material of the HD box is heavy duty.
- Consist of a few components, and are therefore easy to build.
- Easier to stack on top of each other.
- Manages the force from the load securing and other goods stacked on top of it.
- The material is wood and therefore heavy.

Usage

Are used when/because:

- Orders are sent to dealers in the Maastricht area by night delivery.
  - The orders during the night delivery to a dealer are a larger number than the day deliveries, that is why a tertiary packaging is used by night and not by day.
  - The night time orders are transported in a truck, and not a van, which makes it possible to use the HD boxes. In a van there is no room for a HD box.
- The boxes can be reused, and there is a working return flow.
  - In the return flow in Maastricht, the HD boxes are never collapsed when they are empty and transported back to the LDC, which results in that the operators do not have to rebuild boxes and therefore saves time.
- The operators think that the boxes are easy to build and handle.

Figure 26: The HD boxes filled with a few secondary packages. The work station shows that there is no place to go around or between the boxes. The boxes are not always fully filled when transported.

4.4 Usage of packaging products

This section is divided into the subsections Quantity and cost of packaging products and Number of packaging products. In the section about Quantity and cost of packaging products, the order

history, number of orders and estimated usage are presented. This section's purpose is to get a better understanding of which packaging products that have been ordered, how many of each product and the cost for all packaging products. The section about Number of packaging products is divided into Secondary packaging and Tertiary packaging. This section is to get a better understanding of which packaging products that have been ordered and the quantity of each product.

4.4.1 Quantity and cost of packaging products

The section is divided into Order history, Number of order lines and reference quantity and Estimated usage. In the subsection Order history, data is presented regarding which packaging products has been purchased. This data is summarized from the order history, which has been collected and processed to get a better overview. The processed order history can be found in appendices 10.4 Order history: Papyrus and 10.5 Order history: ESC. Furthermore, quantity and cost of the packaging products is presented. In the subsection Number of order lines and reference quantity, the order lines for the period is presented as well as the number of secondary packagings that theoretically should be used. The subsection about Estimated usage includes data regarding usage of packaging products in Maastricht. This data is based on observations and interviews.

4.4.1.1 Order history

This section will present the order history for the packaging products that has been ordered and sent to the LDC in Maastricht. There have been two possible ways of ordering, either from Papyrus or from the ESC in Sweden. These will be further presented below.

Orders from Papyrus

As it can be seen in appendix 10.4, there are no invoices from Papyrus later than August. To get a better understanding why, this has been investigated by interviews with operators at the CDC in Sweden and at the LDC in Maastricht.

The reason why the LDC has stopped ordering from Papyrus is because in June, a third-party logistics took over the business, after they did that, they decided to stop ordering from Papyrus and then started to order only from the ESC in Sweden. The reasons why is presented below:

- It was a lot of different packaging products in web-PULS and in the inventory.
  - Due to ordering both from Papyrus and the ESC in Sweden.
- There were no standard working process regarding which packaging products should be used.
- The operators think that the freight cost from Papyrus is high in comparison to the freight cost from the ESC.
  - The ESC freight cost is not included in the packaging cost. The packaging products are sent in a truck that transports spare parts for the LDC. The truck is paid for per truck used, and because the packaging products does not take up a lot of extra space in the truck, the packaging products, in most cases fits in the truck. If the packaging products does not fit in the truck, it is

shipped in the next truck that goes to the LDC. Consequently, they never pay extra to ship the packaging products.

- The freight cost from Papyrus is included in the packaging invoices. There is no contract between Volvo and Papyrus, and therefore the transport cost is not controlled, which can lead to higher transport costs than expected.

- The operators think it is easier to order from the ESC in Sweden.
- From Papyrus, the LDC has to order a predetermined quantity.
  - The predetermined quantity can either be too big or too small in comparison to the quantity that is needed.

After the LDS in Maastricht stopped ordering from Papyrus, the LDC has development an improved procedure regarding packaging. The operators have noted that:

- The product numbers have decreased.
  - An effect of the decreased number of packaging products is that the need for stockholding places in the LDC have decreased.
- An improved working process.
  - The product number decreased. Consequently, the operators can choose from a smaller amount of packaging products and therefore the choosing process is easier.
  - The operators have learned working with the different packaging products. When the packaging types decreased, there was fewer working procedures for the operators to learn.

During the writing of this thesis, it was found that there were no longer a flow of packaging products from Papyrus and therefore it is not further included in this thesis.

Orders from the ESC

The data that is being presented is gathered from the ESC and consists of order history of purchased packaging products from the CDC in Gothenburg to the LDC in Maastricht. This data can be viewed in appendix 10.5.

The period that has been chosen for analysis, is from October 2015 to March 2016. The ending of the period is chosen because there are no available data after March 2016. The choice of the beginning of the period is based upon the information that a third-party logistics began operating the LDC mid-year 2015. With this change in operation, some other changes concerning the packaging were made, as mentioned in the section orders from Papyrus. The intent of the analysis is to mirror the current state, and after August the LDC started to change their working process. When making changes there are often some disorder a period after the adjustment has been made. Therefore, the chosen period starts in October 2015.

A summary of the order data is found in table 6 regarding the quantity ordered and what the cost of the ordered products were during the period October 2015 to March 2016. The data has been divided into categories of secondary packaging, tertiary packaging, labels and other. Important to keep in mind when further reading these findings is that there has been no consideration taken to the balance of inventory before and after the period that has been chosen, due to insufficient data.

This might lead to a possible source of error that needs to be accounted for when interpreting the result.

	Quantity	Cost [SEK]
Blue box	1 550	45 917,00
Cardboard box	7 158	339701,31
Plastic bag	140 000	42 390,00
SECONDARY TOTAL	***148 708***	***428 008,31***
One way	4 635	308 682,45
HD	11 106	513 266,68
TERTIARY TOTAL	***15 741***	***821 949,13***
LABELS TOTAL	***1 231 069***	***140 056,23***
OTHER TOTAL	***56***	***300,58***
GRAND TOTAL	**1 395 574**	**1 390 314,25**

Table 6: A summary of the data from the ESC. The data gathering displays the purchase of packaging products during October 2015 to March 2016.

Secondary packaging

As can be seen in the table 7, the average cost per unit is presented; the cost is divided by the quantity. The average cost per unit for Blue boxes is 29,62 SEK, the Cardboard Boxes is 47,46 SEK and the Plastic bag is 0,30 SEK.

	Quantity	Cost [SEK]	Average cost per unit [SEK]
Blue box	1 550	45 917,00	29,62
Cardboard box	7 158	339701,31	47,46
Plastic bag	140 000	42 390,00	0,30
SECONDARY TOTAL	***148 708***	***428 008,31***	**2,88**

Table 7: The relation between cost and quantity for secondary packaging.

Tertiary packaging

Since the boxes consist of several parts it is difficult to determine how many boxes that have been ordered. In the table 6, all parts for the tertiary packaging is presented in the columns quantity and cost. Therefore, the number of boxes cannot be presented but will be further investigated in the analysis chapter. However, table 8 shows the cost for one One Way box and one HD box.

	Cost [SEK]	Volume [dm^3]
One Way (F4)	437,46	1 538
HD (L4)	416,92	778

Table 8: The cost and volume for one type of tertiary packaging, which includes all the parts that the box extends of.

4.4.1.2 Number of order lines and reference quantity

This section is divided into Order lines and Reference quantity. In the section Order lines, data is presented regarding the amount of order lines. The section about reference quantity will present how many secondary packagings products that should be used during the period. This data will be used to compare the order lines quantity with the reference quantity in the analysis chapter.

Order lines

Orders are sent from dealers to the LDC and can for example be all spare parts that is needed for one repair or parts that is needed to be refilled in the dealer's own stock. One order consists of several order lines, and one order line is one type of spare part. There can be more than one spare part in one order line. In table 9 the number of order lines for the period October 2015 to March 2016 is presented. The order lines consist of the ordering from dealers both in the Maastricht area (LDC) and France (SDC). The order lines are divided in day deliveries and night deliveries. The total number of order lines for the LDC are 72 425 during day deliveries and 295 542 during night deliveries. For the SDC there are only orders for the night deliveries which amount to 186 628, which leaves a total of 554 595 order lines for the period.

	LDC		SDC	
	Day	Night	Day	Night
October	11 860	49 301	-	28 067
November	11 376	52 585	-	26 247
December	12 816	51 315	-	28 509
January	13 095	51 747	-	29 818
February	11 596	45 357	-	26 848
March	11 682	45 237	-	47 139
Total	**72 425**	**295 542**	**-**	**186 628**
Grand Total	**554 595**			

Table 9: The number of order lines for the period October 2015 until March 2016. The column LDC represent the numbers in Maastricht and the column SDC represent the numbers in France.

Reference Quantity

Figure 10 shows how many secondary packagings that theoretically should be used based on the number of orders sent from Maastricht during the period October 2015 to March 2016. This data was compiled by the company. The number will be used as a reference for a comparison with the order quantity. There is no corresponding data regarding how many tertiary packagings that should be used.

	Secondary packaging
Reference quantity	**158 259**

Table 10: Reference quantity for the secondary packaging. The number has been compiled by the company.

4.4.1.3 Estimated usage

For secondary packaging there will be a table regarding the usage of the packaging products. This data is based on interviews with the operators' estimations of how frequent the different types are used in relation to each other. This will be used later in the analysis for a comparison between order history and reference quantity.

In table 11 the different secondary packaging's usage based on the operators' in Maastricht estimations are presented. This will be used to see if the perceived usage correlates to the ordered secondary packaging products in the analysis chapter.

Secondary packaging	Blue boxes	Cardboard boxes	Plastic bags
Usage in comparison to each other	75%	17%	8%

Table 11: Operators estimations of how frequently the different secondary packagings are used in relation to each other.

For tertiary packaging there will be no further investigation of which packaging products that are used most frequently, because the usage depends on the different flows. For the night deliveries, the HD boxes are always used and for delivery to France the One Way boxes are used.

4.4.2 Number of packaging products

This section will investigate how many types of packaging products that are used. In the frame of reference, the pareto principle was presented. It states that often 80 % of the effects come from 20 % of the causes. To have a large amount of different products is costly and takes up a lot of storage place. The pareto principle can therefore be useful when investigating the number of products in a system to find out if there is a small group of products that cause a large amount of effects, for example costs. In this case, the products will be divided by the categories of secondary and tertiary packaging.

4.4.2.1 Secondary packaging

The section of secondary packaging will be divided further into categories because the different packaging types have different functions and should be compared to similar products.

There are only two different types of Blue boxes ordered via the ESC. However, the observations showed that there are more types that are used, the reasons for this can be that they are being reused and that the inventory before the period is unknown. This means that there are insufficient data for applying the pareto principle. Therefore, this section will only include Cardboard boxes and plastic bags, which will now be further presented.

Cardboard boxes

Figure 27 displays the order quantity for the Cardboard boxes during the period. The total order quantity for all Cardboard boxes is 7 158 units and the total number of different products is 16. In the figure, the six first products represent almost 80 % of the total amount of ordered Cardboard

boxes. One of the main factors when deciding which Cardboard box to use is the volume of the box. Data regarding the volume of the Cardboard boxes can be found in figure 28.

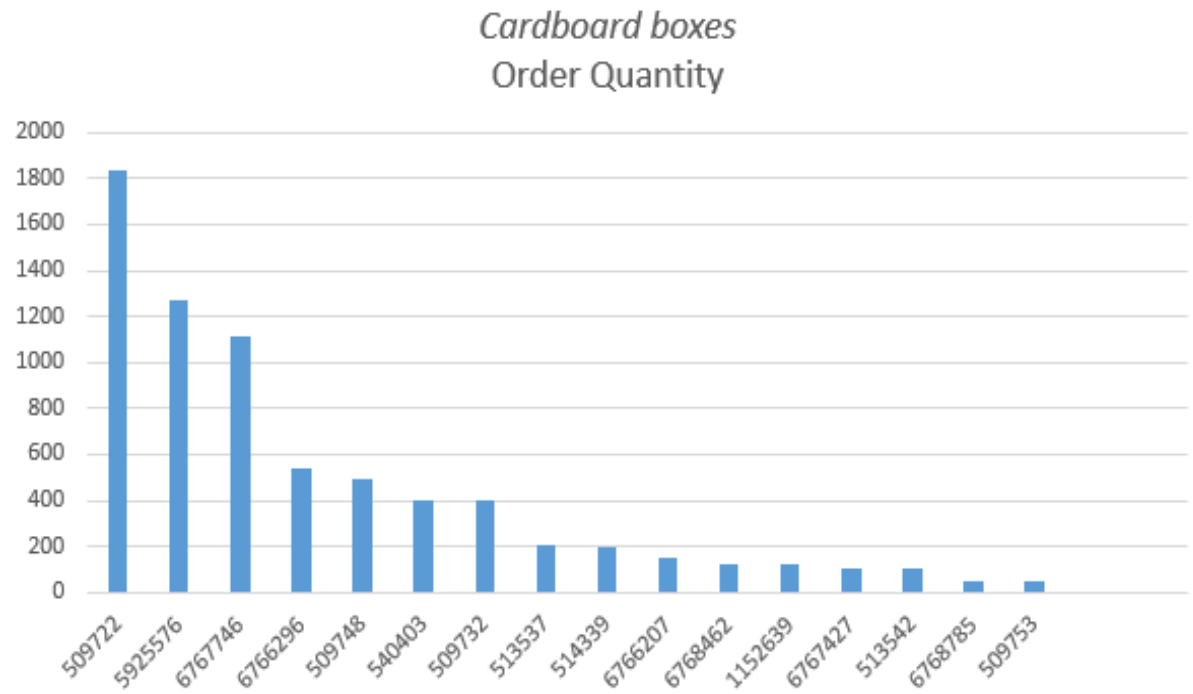


Figure 27: Order quantity for Cardboard boxes. Total number of products is 16.

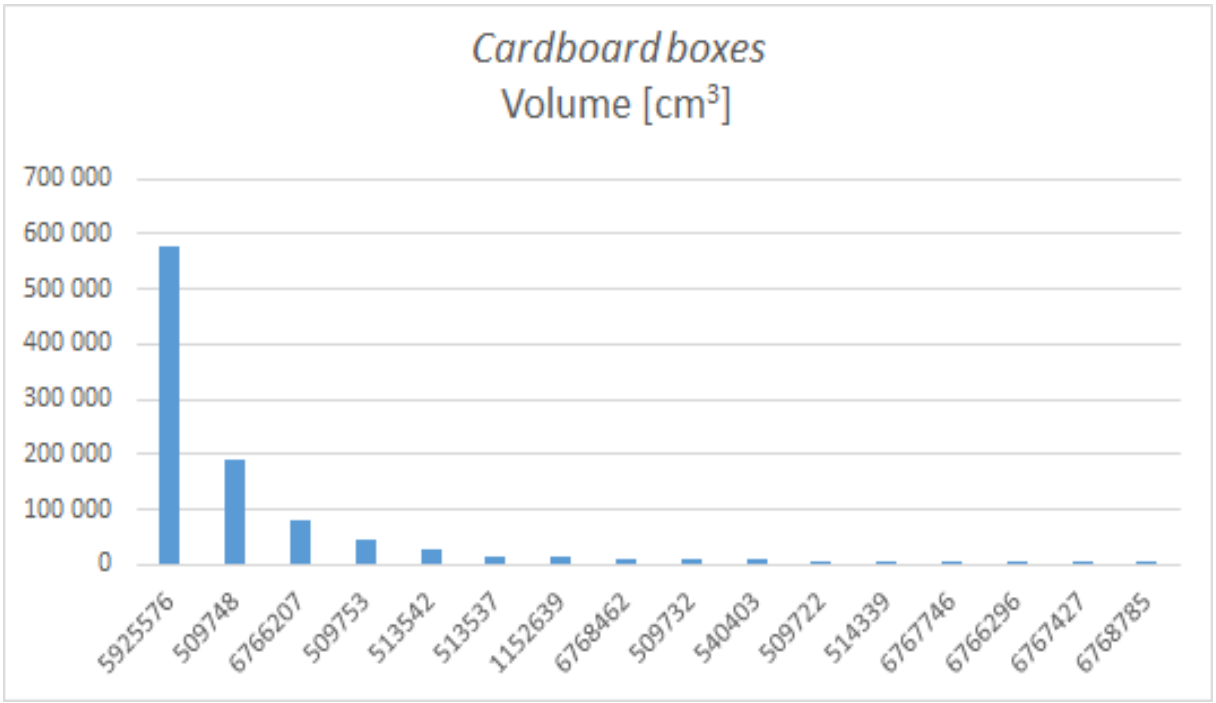


Figure 28: The different volumes of the cardboard boxes.

Plastic bags

Figure 29 displays the order quantity for plastic bags. The total order quantity for the period is 140 000 units and the total number of different types of plastic bags is 9. In figure 29 it can be seen that there is one type of plastic bag that is ordered more frequently than the others. This type

of plastic bag alone stands for 80 % of the total order quantity. One of the main factors when deciding which plastic bag to use is the volume of the box. Data regarding the volume of the plastic bags can be found in figure 30.

Figure 29: Order quantity for plastic bags. Total number of product numbers are 9.

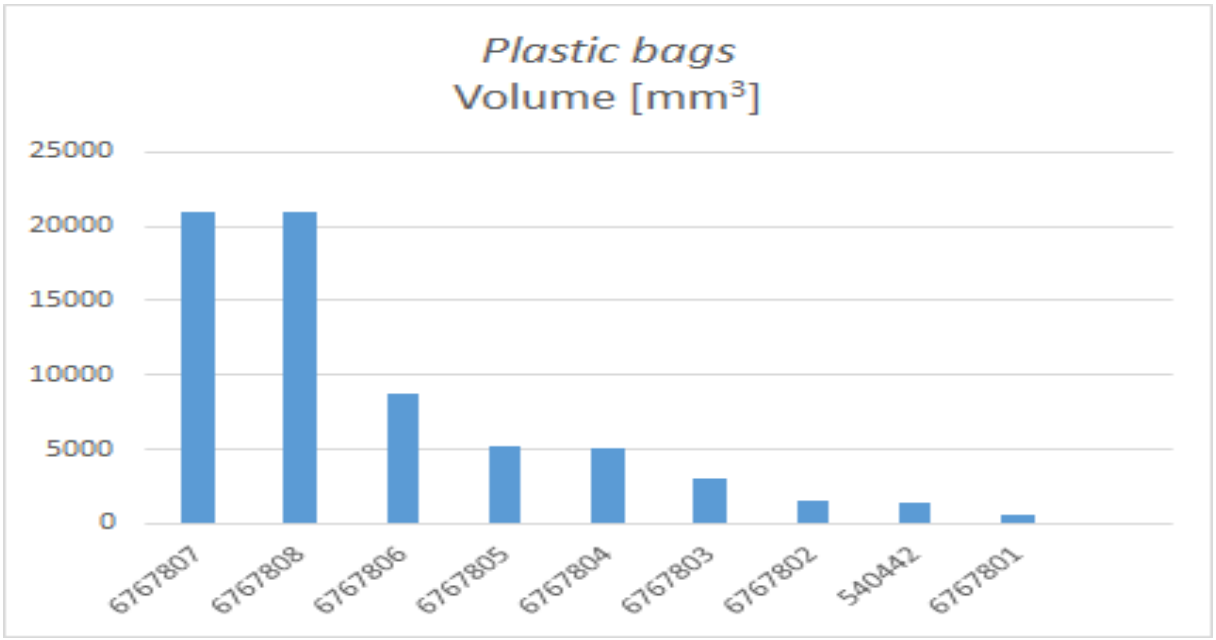


Figure 30: The volumes of the plastic bags displayed in a diagram.

4.4.2.2 Tertiary packaging

The tertiary packaging consists of one size of HD boxes and one size of One Way boxes. The number of parts for a box is not reducible because all the different parts are needed, and therefore there will be no further investigation of the amount of product numbers in this section. However, there will be an analysis whether or not it is possible to change the One Way box for the

deliveries to France, which consists of a larger number of different parts, to a HD box of a comparable size, in the section 5.5.2.3 Tertiary packaging.

5 ANALYSIS

In this chapter the analysis of this thesis and the relationship between the theoretical framework and the empirical findings is presented. The chapter is divided into the sections Current state map, Packaging procedures and Usage of packaging products and correspond to the sections with the correlating names in chapter 4 Empirical findings.

5.1 Current state map

In this section there will be an analysis of section 4.2 Current state map. The section is divided into different process steps as follows: External Stock Control (ESC), Receiving, Inventory: Storage, Inventory: Packaging area, Packing orders, Delivery area, Dealer and Return flow.

5.1.1 External Stock Control (ESC)

The packaging products can be either ordered by order point or manually by operators at the LDC from the ESC in Sweden. The process for ordering manually occurs by observing if the stocking area is empty. If this is the case, the operators order new packaging products. The process ordering does not occur continuously. This can lead to that the stock becomes empty as none of the operators have ordered new packaging products. The consequences of this is that the packaging process cannot proceed, which can be seen as a waste, waiting for packaging products.

The manual ordering process demands extra time checking in web-PULS, as mentioned in the section 4.2.1, External stock control. The reason why is because, when the operators at the LDC order manually, they must update the inventory number in web-PULS and then email the operators at the ESC that they need more packaging products. Thereafter, the operators at the ESC must double check if the number of inventory is updated. If the system is not updated, they must send an email back to the LDC and ask why they need new packaging products. This process is time consuming and demands overprocessing, which can be seen as a waste.

The reasons why some of the packaging products is ordered manually are because they can be reused a number of times that can vary between five to fifteen times. This variation of reused times can lead to uncertainty of the inventory of products and how much packaging products it is in circulation.

5.1.2 Receiving

A truck transports spare parts and packaging products from Sweden to the LDC in Maastricht. The packaging products are loaded where there is space left in the truck. This result in that the waste, unnecessary transport, is eliminated, because, there is no extra truck for transporting packaging products.

5.1.3 Inventory: Storage

Close to the inventory storage in the LDC there is a spot for building up tertiary packaging. This leads to a short transportation between the two spots, and the waste, unnecessary transport is almost eliminated.

Since there are many different secondary packaging and tertiary packaging products, the packaging products takes up space in the storage area in the LDC. If the packaging types number decreases, it will lead to that the demand for locations in the area decreases. Furthermore, operators have mentioned that having product numbers in web-PULS is a cost.

5.1.4 Inventory: Packing Area

The tertiary packaging is prepared by being built up on a daily basis, based on the demand for the day. This leads to that there is no overproduction, which can be seen as a waste.

5.1.5 Packing orders

An order is packed in a secondary packaging, the operators decide the packaging type and the packaging size, that should be used for the order. This process is not standardized and occurs manually by the operator's experience. When basing decisions on experience, there is always a human factor that can lead to a wrong choice. Furthermore, if the operators choose a packaging size that does not fit the order, either the size can be too small or too big for the order. If this is the case the operators repack the order in another packaging size, this is time consuming, which can be seen as waste. If the operators take a packaging size that is too small and do not repack, it can lead to that the order can be packed too tight in the box, which can result in defects on the product, which is a waste. If the operators take a packaging size that is too big for the order, and the operators do not repack, the packaging content consists of empty space and therefore take up extra space in the truck, which can be seen as a waste, unnecessary transport. This will also lead to additional transport costs.

When reusing Blue boxes, old labels are left on the boxes, if the operators miss to cover these labels, it can lead to waste, since it can create confusion later in the flow and the orders can be transported to wrong dealers, which can be seen as a waste, defects and new unnecessary transport. This lead to that the operators need to be careful to cover old labels. To decrease defects this process can be standardized and controlled better.

5.1.6 Delivery Area

This section is divided into day deliveries, night deliveries and deliveries to France.

5.1.6.1 Day deliveries

When transporting day deliveries a van is used. If the van is not full during transport, this can be seen as a waste, unnecessary transport. To get a better filling rate in the van a new system can be implemented. This analysis will not be further conducted in this thesis.

5.1.6.2 Night delivery

The truck for the night delivery is filled with one single layer of HD boxes. This leads to that the truck is not fully filled, which can be seen as a waste, unnecessary transport. The reason for only have one layer of HD boxes is because neither the dealer nor the truck driver, have equipment to unload boxes that are stacked in several layers.

Since the boxes only can be packed in one layer in the truck, the operators have chosen to always have the same height of the box, HD box (L4). Furthermore, they have also decided to not collapse the boxes after being used. The reason why is because it is seen as time consuming to rebuild boxes. However, the height of the boxes is an ergonomic problem, both for operators at the LDC and the employees at the dealers, since they have to bend over to put or pick up boxes from the bottom of the box.

In some cases, the boxes to dealers are not completely full. When the spare parts are delivered to the dealer, the employees must bend to unpack the orders, which can be seen as an ergonomic problem.

5.1.6.3 Deliveries to France

The truck for the French deliveries is filled with stacked One Way boxes. The goods are delivered to a hub, where it is possible to unload the boxes with correct equipment.

In some cases, the One Way boxes are not completely utilized, which can be seen as a waste, unnecessary transport.

The ergonomic problem for the One Way boxes are the same as mentioned in the section 5.1.6.2, Night delivery. But, for the One Way boxes it is not possible to take off collars to decrease the height of the box, since the cardboard box is produced in one piece with the height of four collars.

5.1.7 Dealer

At the dealer the employees save the used Blue boxes and put them in HD boxes that have been emptied of orders. The HD boxes are then picked up in a milk run, which make the reuse of packaging products possible. The employees at the dealer do not sort out the blue boxes by size, which lead to that the Blue boxes are unsorted when received at the LDC. The result is that the operators at the LDC must sort the Blue boxes, which lead to a waste, overprocessing.

5.1.8 Return flow

This section is divided in two separate sections, Returns from LDC dealers and Returns from France delivery.

5.1.8.1 Returns from the night delivery

A milk run flow is a process that should be standardized to increase the usage of returnable packaging. In the return flow from dealers in Maastricht the tertiary packaging is not collapsed, this lead to that the milk run transport is not fully filled, which can be seen as a waste, unnecessary transport.

There is no standardized process to control the flow regarding which packaging products is sent back and how many.

5.1.8.2 Returns from the France delivery

There is a return flow from France with spare parts that needs to be returned to the CDC in Sweden. The current situation is that there is no continuous return flow from France regarding used packaging products. However, some packaging products are sent back as well, but the packaging products are mostly unsorted and not used as a packaging products at the LDC in Maastricht. The fact that Maastricht does not use this types of packaging products, leads to that the packaging products must be thrown away, which is an environmental aspect to take into consideration. The returned packaging products that are not used in Maastricht is mainly sent to France from the CDC in Sweden. If the packaging products that are sent to France are the same as the packaging products that are used in Maastricht, a smaller amount of the returned packaging would be thrown away.

5.2 Packaging procedures

This chapter will present the analysis connected to the corresponding section in the empirical findings, section 4.3 Packaging procedures. The section is divided into Packaging process and Packaging types. The segment about packaging types is further divided into Secondary packaging and Tertiary packaging.

5.2.1 Packaging process

When picking and packing orders, the operators only handle one order at a time. This makes the process more secure and prevents mixing up orders. Preventing the orders getting mixed up, hinders other consequences such as repacking orders, extra transport if the wrong order is sent to the wrong dealer and waiting done by the dealers if the order is not being delivered to them when supposed to. These consequences answer to the wastes, defects and overprocessing. By handling one order at a time, wastes in the system can be reduced.

5.2.2 Packaging types

In this section the different types of packagings will be analyzed. The section is divided into Secondary packaging and Tertiary packaging.

5.2.2.1 Secondary packaging

This analysis will be conducted in four different sections: General, Blue boxes, Cardboard boxes and Plastic bags. Furthermore, the packaging products will be analyzed regarding their characteristics, negative and positive factors.

General

The operators can choose between three main types of secondary packaging; Blue boxes, Cardboard boxes and plastic bags. The choice is dependent on the characteristics of the order, as mentioned in the section about packaging types. Within each category, there are several packaging types to choose from. The wider the range of packaging types, the harder the decision is to make. Furthermore, a lot of different packaging products take up larger storing space and are costly to have in web-PULS, which can be considered as wastes. Whether or not it is possible to reduce the number of packaging products will be further analyzed in section 5.3.2 Number of packaging products.

Blue boxes

The material of the Blue boxes is plastic which has the favorable characteristic that it is light weight. This is a positive attribute if the transport is payed for by weight. Another benefit is that the plastic is reusable. Disadvantages with the Blue box is that it cannot be used to hold heavy, fragile or dangerous goods, which limits its usage. However, the boxes can hold heavy and fragile goods better, in comparison with the plastic bags.

As mentioned, the Blue boxes are returnable. This contributes to environmental benefits, that fewer transactions have to be made and that the disposal process is less frequent. The disadvantages are the additional sorting, storing and transport that comes with the return system. The sorting of the Blue boxes is very time consuming and can lead to increased cost in form of overprocessing, which can be seen as a waste.

Also, the current state is that the LDC inventory of the boxes is high, which takes up a lot of storage space. These activities create waste in the system.

The transport of the return flow however, is solved with milk runs which reduces the waste of the system.

The ergonomics of the boxes are good. The operators like working with them and the building process is fairly easy.

Furthermore, at the dealer the employees think that the Blue boxes are the favorable secondary packaging product to be used. Since, in this case, the dealer can be seen as a customer, it is important to take the dealer's needs into consideration.

Cardboard

The material characteristics of corrugated cardboard includes lightweight and high performance. It is also absorbent of moisture, which can be both beneficial and disadvantageous. The benefit is that it can absorb dangerous liquids. The negative aspect is that its mechanical properties is affected and the compression strength weakens, so if the box is exposed to damp surroundings it might collapse. One other function of the Cardboard boxes, in this case, is that it provides more protection than the plastic Blue boxes and plastic bags and is for this reason used for fragile goods. The Cardboard box is also more stable than the plastic Blue boxes and plastic bags, and is therefore used for heavy objects.

The Cardboard boxes are not used as returnable packaging in Maastricht. The positive aspect is that this leads to that the boxes do not require a return flow system. Furthermore, another benefit of the fact that they are not returned, is that the boxes are disposed of when used, there is no risk of confusion concerning the dangerous goods labels. The negative perspective includes the disposal management and the effects on the environment. However, the Cardboard boxes can be reused and are reused at other LDC's.

The ergonomics of the boxes are fairly good. The operators perceive the boxes to be somewhat harder and take slightly more time to build then the Blue boxes. The extra time to build the boxes can be seen as waste. The boxes also need to be taped and/or stapled to keep together, which require extra material and tools compared to the Blue boxes, that need no extra materials and tools.

Furthermore, the employees at the dealer think that the handling process of the Cardboard boxes are complicated, due to the disposal handling process.

Plastic bags

The plastic of the plastic bags is very lightweight and soft. The softness is beneficial because the plastic can adjust to the product and fit most shapes. It will also take up less space when transported, which reduces waste. The plastic is transparent which leads to that it is easy to see what it is in the bag without having to open the packaging first, the packaging will communicate information about the content. A negative aspect of the plastic material is that is not very protecting of the products, and therefore cannot be used to package fragile products.

The plastic bags are currently not reused, but there are reported cases where the bags have been used as returnable packaging with a successful result in other LDC's. Important to keep in mind, is that if the plastic bags are reused, the plastic bags have to be handled with care, of all parties involved.

The ergonomics of the plastic bags is good, they are easy to handle and very light.

5.2.2.2 Tertiary packaging

In this section an analysis will be conducted in two different sections, One Way boxes and HD boxes. Furthermore, the packaging will be analyzed regarding their characteristics as well as negative and positive factors.

One way

The One Way packaging is used for deliveries to France. This packaging is not the favorite among the operators, but a common belief is that this packaging is the only one that should be sent to France.

The material of the One Way packaging is cardboard which has the favorable characteristic that it is light weight. This is a positive attribute if the transport is payed for by weight. The material is also absorbent of moisture, which can be disadvantageous. The negative aspect is that its mechanical properties is affected and the compression strength weakens, so if the box is exposed to damp surroundings it might collapse.

The One Way packaging extends of many different parts, this leads to many steps in the building process which makes it harder to build the box, in comparison to the HD box. This can be seen as a waste, because it is time consuming. Moreover, the building process demands tools, which create cost. Another, negative aspect is that the One Way boxes are in one size and cannot be rebuilt to an another size, like the HD box. A negative aspect of the size, is that it is big, which lead to that in most cases the building process demands two people. Additionally, the consequence of the big size makes it hard to move.

As mentioned before, the One way packaging extends of many parts compared to the HD boxes, having product numbers in web-PULS are a cost, which is mentioned in the section, 5.1.4, Inventory: Storage.

In most cases in Maastricht, the One Way packaging is not used as returnable packaging. The reason is because there are no standard or guidelines for a return flow from France. The positive aspect of not reusing packaging products is that they do not require a return flow system. However, the One Way packaging can be reused and the packaging are coming back in a return flow, so called milk run, which reduces the waste of the system. Reusing the packaging leads to that fewer transactions have to be made and that the disposal process is less frequent. When the packaging products are returned they are in some cases collapsed and sometimes not collapsed. In the case when they are not collapsed, some of the packaging products are damaged and cannot therefore be reused. In both cases the operators must sort them out before being reused. This is time consuming and can be seen as a waste, overprocessing. Furthermore, if the sorting is difficult the operators throw it away instead. This approach is negative for the environment and costly.

When packing in the One Way box the degree of filling is not always 100 %, which leads to waste, unnecessary transport. Furthermore, if a box is too small for the order the operators solve

this not by starting to fill a new box, instead orders are placed beside the box or on top of the box during transport. This can lead to that the orders do not have the same protection as the other orders in the box during transport. This can lead to defects, which is seen as a waste.

The height of the One Way box can create ergonomic problems. The One Way packaging is always in one size, and therefore it is not possible to change the height in comparison to the degree of filling.

During transport to the hub, the goods are loaded and secured by a rope in the truck. As mentioned before, the cardboard material can collapse if exposed to external forces. Furthermore, if the climate is damp a combination with external forces can increase the damage of the collapse. This can lead to that the operators do not secure the goods with the right amount of force, which can lead to security risks.

HD

The HD boxes are only used for delivery by night to dealers in the Maastricht area. A common opinion among the operators is that the HD box is the preferred tertiary packaging to be used.

The material of the HD boxes is wood which has the favorable characteristic that it is heavy duty. The wood is also heavy which can lead to that the boxes are hard to handle. Furthermore, the cost can be higher in comparison to the One Way packaging if the transport is payed for by weight. A benefit is that the wood is reusable, this leads to that the HD box is reusable, which the LDC in Maastricht utilize. This contributes to that fewer transactions have to be made, the disposal process is less frequent and reusing is also environmentally beneficial. The transport of the return flow however, is solved with milk runs which reduces the waste of the system.

During transport the boxes are loaded in one layer, as mentioned before, this leads to that the operators at the LDC and the employees at the dealer never collapse the boxes or take off collars from the HD boxes when transported out to dealers. The use of the same height of HD box leads to that the handling of the boxes is easy, because they never have to rebuild it since they are returned built up. A consequence of never take off or add collars is that when packing the box with orders it can lead to that the degree of filling is not always full, which lead to a transport waste. Furthermore, if a box is too small for the orders the operators solve this by start to fill a new box. This can lead to that the second box are not fully filled with orders, which is seen as a waste, unnecessary transport.

The operators most preferable tertiary packaging is the HD box, the reason why is because the building process is fairly easy, the boxes extend of fewer parts and leads to a small amount of steps in the building process, in comparison to the One Way packaging. A negative aspect of the size and weight of the box, is that it is big and heavy, which lead to that in most cases the building process demands two people. Additionally, another consequence of the big size and heavy material makes it hard to move.

The HD boxes are more stable and heavy duty than the One Way packaging.

5.3 Usage of packaging products

This section will analyze the order data that was presented in the empirical findings. The section is divided into Quantity and cost of packaging products and Number of packaging products that corresponds to the correlating sections in chapter 4 Empirical findings.

5.3.1 Quantity and cost of packaging products

This section is divided into Order history, Average cost of packaging products and Comparison of order quantity and usage. The first section will analyze the order history regarding the different packaging types. The order quantity and cost will be in focus. Then the average cost of packaging products will be presented for both secondary and tertiary packaging. In the section Comparison of order history and usage, all the data presented in the empirical findings under the section Quantity and cost of packaging products will be analyzed to see if the ordering and usage of packaging products are reasonable.

5.3.1.1 Order history

In this section, the secondary and tertiary packaging will be analyzed with focus on quantity and cost. A summary of table 6 regarding the quantity and cost from section 4.4.1.1 Order history is presented below in the form of pie charts in figure 31. The figure shows each category's percentage regarding quantity and cost. Furthermore, these will be investigated by each category, beginning with Secondary packaging followed by Tertiary packaging, Labels and Other.

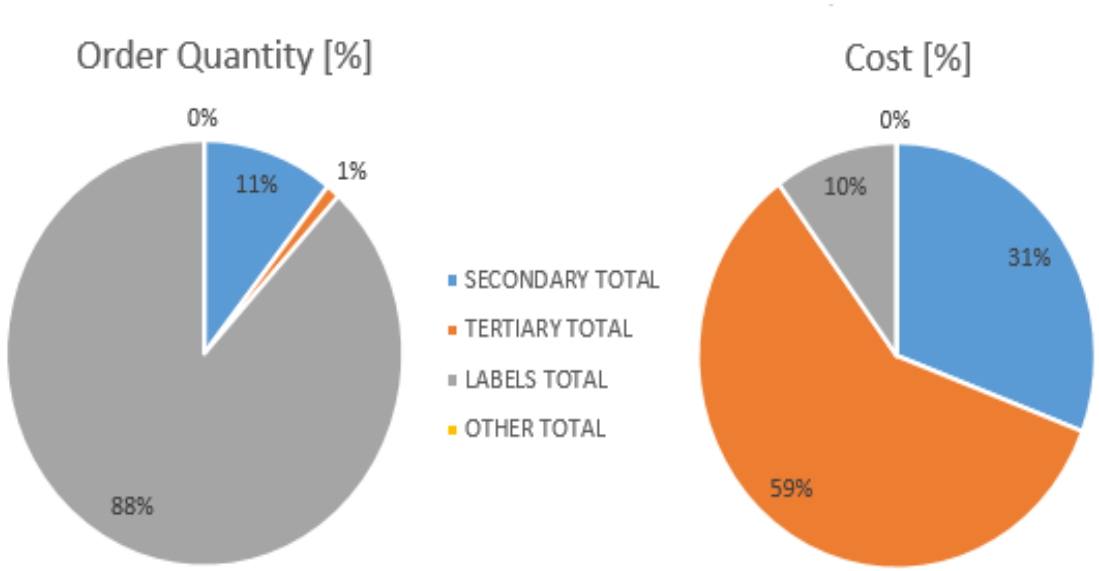


Figure 31: The figure shows the order quantity of each packaging category in percentage in relation to all ordered packaging, as well as the cost of each packaging category in percentage in relation to the cost of all ordered packaging.

Secondary packaging

As shown in figure 31, secondary packaging stands for 11% of the ordered quantity, and about a third of the costs. In this category there are three subcategories: Blue boxes, Cardboard boxes and plastic bags. As can be seen in figure 32, which is generated from table 6 in section 4.4.1.1 Order history, plastic bags are by far the most ordered product at 94% of the total order quantity for secondary packaging. Second comes Cardboard boxes at 5% and third Blue boxes at 1%. This does not correlate to the observations at the LDC, when plastic bags were perceived as the least used secondary packaging and the Blue boxes as the most frequent used secondary packaging. Regarding the plastic bags, the reason for this is because the plastic bags sometimes are used as a primary packaging for small spare parts such as screws and bolts. Therefore, it is ordered more frequent than the other secondary packagings. Regarding the Blue boxes, reasons for the difference can be that they are reused as well as that they have a large amount of inventory of this product in the LDC. These factors contribute to that the Blue boxes are ordered less frequent.

Comparing the order quantity with the cost of each subcategory, displayed in figure 32, it can be seen that even though the plastic bags are great in quantity they only answer to 10%, 42 390 SEK, of the total costs. The subcategory that represent the highest cost is Cardboard box with 79%, 339 599 SEK.

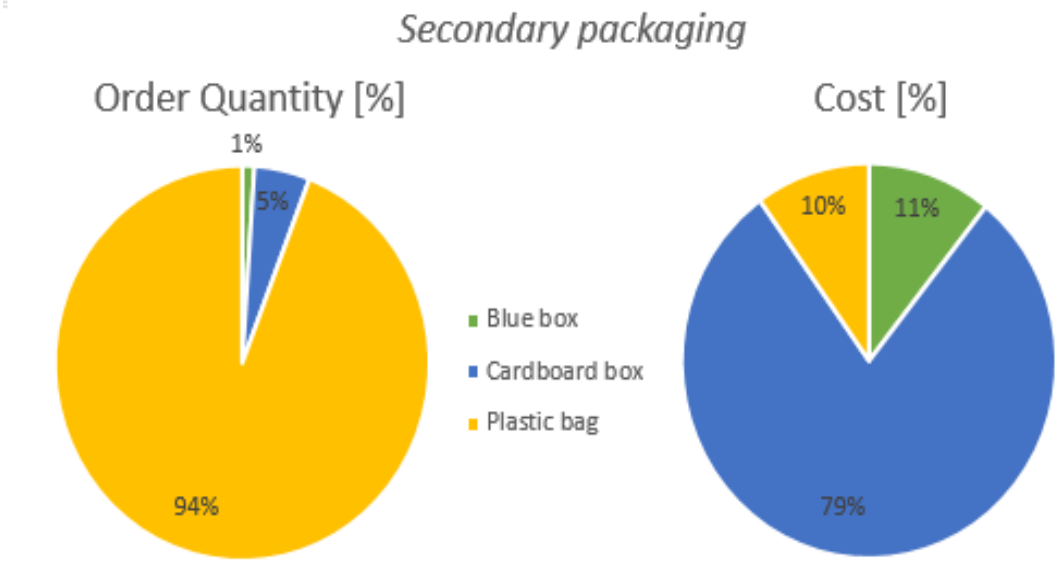


Figure 32: The table shows the relation between the subcategories of secondary packaging regarding order quantity and cost, in percent.

Tertiary packaging

Looking into the tertiary category, it can be gathered from table 31 that the category only stands for 1% of the total quantity ordered. However, as seen in table 31, the category is connected to the largest cost: 59% of the total costs, 821 949,13 SEK. In this category, subcategories of One Way and HD is found. In table 33, the relation between these subcategories is displayed with

regard to cost. From table 8 in section 4.1.1.1 Order history, it can be gathered that the cost for one One Way box (F4) is 437,46 SEK and one HD box (L4) is 416,92 SEK. However, these two boxes cannot be compared directly because of their different functions and volumes but will be further analyzed in the next section Average cost of packaging products.

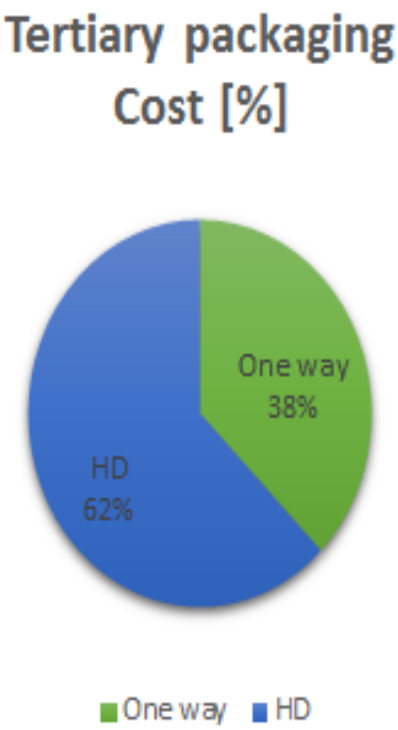


Figure 33: Shows the relation between One Way and HD concerning costs.

Since the boxes consist of several parts it is difficult to determine how many boxes that have been ordered. To make an assumption of how many boxes that are ordered, the outer frame of the One Way and the collars of the HD have been used as a reference. The outer frame was chosen because it is rarely reused and therefore represents how many new boxes that are ordered. A correlated product was chosen for the HD box; the collar. Since the LDC in Maastricht always uses four collars for their boxes, the ordered number of collars was divided by four to get the number of boxes. A summary of this can be seen in table 12.

Box type	Product name	Ordered quantity	Number of boxes
One Way:	Outer Frame	780	780
HD:	Collar	4 900	1 225

Table 12: Number of tertiary boxes based on number of frames/collars that was ordered during the period October 2015 to March 2016.

Labels
In figure 31, it was visualized that labels are the largest category considering order quantity with its 88%, and stands for 10 % of the costs. One label is used for one packaging, and additional labels are used for special occasions such as, for example, dangerous or fragile goods. From the observations in Maastricht, the usage of labels was found to be normal, meaning that the number of labels used seemed to be the amount that was needed to ensure the right information was communicated.

Other
In figure 31, it can be read that the category Other is considered to be 0 % in relation to the other categories. In this category two different packaging products can be found. These packaging types are primary packaging, which is not part of the scope. The fact that the quantity and cost of this category is miniscule in comparison to the other categories, in combination with the products of the category being outside the scope, this category is, from here on, not further analyzed.

5.3.1.2 Average cost of packaging products

The section will analyze the average cost of the different packaging products. First the average cost of Secondary packaging will be analyzed. Thereafter, the average cost of tertiary packaging will be analyzed.

Secondary packaging
The average cost for secondary packaging can be seen in table 7 in section 4.4.1.1 Order history. The conclusion regarding this table is that the plastic bags have the lowest average cost and therefore are the best regarding the economical aspect. This needs further analysis regarding how many times the different types can be reused and a deeper research comparing the volume of the different secondary packagings.

As mentioned, the reuse of the secondary packagings can be taken into consideration. To illustrate the current situation of the average cost in Maastricht, the reuse of the Blue boxes will be taken into account which is displayed in table 13. The new average cost for the Blue boxes is 2,04 SEK per time used. The plastic bags still have the lowest average and therefore are the best regarding the economical aspect.

As previously mentioned, plastic bags can also be reused. This is not the case in Maastricht, therefore this will not be further analyzed in this thesis.

	Adjusted order quantity*	Cost [SEK]	Average cost per unit [SEK]
Blue box	22 475	45 917,00	2,04
Cardboard box	7 158	339 701,31	47,46
Plastic bag	140 000	42 390,00	0,30
SECONDARY TOTAL	***169 633***	***428 008,31***	**2,52**

*takes the reuse of Blue boxes into consideration

Table 13: The average cost for secondary packaging.

Tertiary packaging

In table 8 in section 4.4.1.1 Order history, the different costs of the tertiary boxes are displayed. An approach in this analysis is that the One Way boxes are not reused in Maastricht. Furthermore, The HD boxes are reused, and this approach will be taken into consideration in this analysis. Because the volumes of the different boxes are adjusted to their purposes in the different flows, the analysis will be divided into Night delivery and Delivery to France

Night delivery

For night deliveries in the Maastricht area, smaller size of HD boxes are used than for delivery to France; the L4 size. In the table 14 there is also a One Way box (L4), which is a comparable size to the HD box. The cost of the HD box (L4) is 416,92 SEK and the cost of the One Way box (L4) is 247,82 SEK, as can be seen in table 14. However, the HD boxes can be reused approximately 10 times, as mentioned before. If the box is reused 10 times the cost for the HD box (L4) becomes 41,69 SEK per time used. This is beneficial from an economical point of view compared to the One Way box (L4). The HD box only have to be reused one time to be more economical than the One Way box (L4).

	Cost [SEK]	Volume [dm^3]	Reused	Cost if reused [SEK]
One Way (L4)	247,82	739	0	
HD (L4)	416,92	778	10	41,69

Table 14: The cost and volume of the One Way box(L4) and HD box(L4) related to each other. The table also shows the cost per time if the box is reused. This is based on that the HD boxes can be reused 10 times and that the One Way boxes are not reused.

Delivery to France

Because the One Way box (F4) is adjusted for delivery to France and therefore need a larger volume, a comparison with a corresponding size of a HD box (F4) is interesting. The cost of the One Way box is 437, 46 SEK and the cost for the HD box (F4) is 612,32 SEK. This gives the

result that the One Way box (F4) is the most economical regarding cost. However, the HD boxes can be reused approximately 10 times, as mentioned before. If the box is reused 10 times the cost for the HD box (F4) is 61,23 SEK per time used, which is far more economical than the One Way box (F4).

	Cost [SEK]	Volume [dm^3]	Reused	Cost if reused [SEK]
One Way (F4)	437,46	1 538	0	437,46
HD (F4)	612,32	1 674	10	61,23

Table 15: The cost and volume of the One Way box(F4) and HD box(F4) related to each other. The table also shows the cost per time if the box is reused. This is based on that the HD boxes can be reused 10 times and that the One Way boxes are not reused.

In both cases, the HD boxes were the most economical choices from a purchase perspective. However, this require a working return flow which can generate costs as well.

5.3.1.3 Order quantity and usage

This section will analyze if the ordering and usage of the packaging products in Maastricht is reasonable. Firstly, the secondary packaging will be compared to the reference quantity presented in section 4.4.1.2 Number of order lines and reference quantity. Secondly, the tertiary packagings will be investigated based on order lines.

Secondary packaging

When investigating further, it turned out that plastic bags were almost never used as a secondary packaging, but as a primary packaging to hold small details as screws and bolts. The plastic bags were then put into a secondary packaging. The aim of this analysis is to compare the number of secondary packagings that is ordered to the reference quantity. Therefore, plastic bags will not be included in this section.

In table 16, data regarding the order quantity of the secondary packagings and the reference quantity is presented, as well as the difference between these. The data in the first column Order quantity, is collected from table 6 in section 4.4.1.1 Order history. The Reference quantity can be found in table 10 in section 4.4.1.2 Number of order lines and reference quantity. The difference of the columns amounts to -149 551, which means that the ordered amount is less than expected. One of the reasons for the difference is because the inventory before the period is unknown. This reason is not further analyzed in this thesis. Another reason is that the Blue boxes can be reused, which is further analyzed below.

	Order quantity	Reference quantity	Difference
Blue box	1 550	-	-
Cardboard box	7 158		
Secondary total	**8 708**	**158 259**	**-149 551**

Table 16: The difference between order and reference quantity for secondary packaging. The plastic bags are removed from the category because of reasons presented in the running text.

To further examine the difference between the reference quantity and the order quantity, the estimated reuse of secondary packaging has been taken into consideration. As previously mentioned in section 4.3.2.2 Secondary packaging, the operators estimate that the Blue boxes can be used between 4-25 times. The average number of these estimations is 14,5, which is the number that will be used for calculations in the analysis. Because the boxes can be reused, one box can be used several times and fewer boxes will be ordered. To adjust this, the order quantity will be multiplied with the number of times it can be used. As can be seen in table 17, the order quantity of Blue boxes is 1 550. When multiplying this with the mean times of usage, 14,5, the result is 22 475, as can be seen in the table 16 in the column Adjusted quantity. As also can be seen in the table 17, the new total quantity of secondary packaging is 29 633. When comparing this number to the reference quantity, the new difference amounts to 128 626 pieces less than expected. A possible reason for this is high inventory, can be the reuse and purchase before and after the period. Another possible reason is that the Blue boxes are reused more times than approximated.

	Order quantity	Adjusted quantity*	Reference quantity	Difference
Blue box	1 550	22 475		
Cardboard box	7 158	7 158		
Secondary Total		**29 633**	**158 259**	**-128 626**

* The adjusted quantity takes the reusing of the Blue boxes into consideration.
One Blue box can be used approximately 14,5 times.

Table 17: The difference between the new adjusted quantity, that takes the reuse of Blue boxes into consideration, and the reference quantity for secondary packaging for the period October 2015 - March 2016.

To further examine the reasons for the difference, the subcategories of the secondary packaging will be investigated. Operators have been asked to estimate the usage of the different types of secondary packaging in relation to each other. The result can be found in section 4.4.1.3 Estimated usage. Because there is no data about how many of the ordered plastic bags that are

used as primary packaging in relation to secondary packaging, the analysis of the ordering of plastic bags cannot be made and the percentage that stands for the plastic bags in the usage estimation is removed. Therefore, only Blue boxes and Cardboard boxes is included in table 17.

The estimated usage, in percent, have been multiplied with the reference quantity to get an approximation of how many products that theoretically should be ordered per secondary packaging type. The result of this can be found in table 18, in column Estimated usage.

In the same table 18 in the column Order quantity, how many packaging products that is ordered per secondary packaging type is displayed. In the column Adjusted quantity, the reuse has been multiplied with the ordered secondary packaging.

From the column Difference in table 18, estimated usage is subtracted from the adjusted quantity to see if they correlate to each other. For Blue boxes, this number is -96 219 which means that they are ordered less than perceived by the operators. The reasons why can be that the inventory can be high from previous periods or a wrong estimation from the operators, both regarding number of reuse and usage of each type in relation to each other.

The estimation for the Cardboard boxes is 26 904 as can be seen in table 18, and the difference between the estimated usage and the order quantity is -19 746. Possible reasons can be that the inventory can be high from previous periods or a wrong estimation from the operators.

	Order Quantity	Adjusted quantity*	Estmation of usage in percent	Estimated usage**	Difference
Blue box	1 550	22 475	75%	118 694	-96 219
Cardboard box	7 158	7 158	17%	26 904	-19 746

* The quantity of the Blue boxes is adjusted to compensate for the reuse.

** Based on operators' estimations multiplied with the reference quantity (158 259).

Table 18: In this table the d difference between the adjusted quantity and the estimated usage is calculated.

Order lines per tertiary packaging

For the tertiary packaging, a common belief among the operators in Maastricht is that it is difficult to decide how many order lines that fits in a tertiary packaging. The reasons for this is the variation in filling rate and the size of the orders.

As can be seen in table 19, there are 1 225 HD boxes that are ordered for the period and 780 One Way boxes. Furthermore, the HD boxes can be reused and therefore the order quantity will be multiplied with the number of times it can be used. As previously mentioned, the operator's estimate that the HD boxes can be used between 5-15 times. The average of these numbers is 10

which is the number that will be used for calculations in the analysis. As can be seen in table 19, the order quantity of HD boxes is 1 225. When multiplying this with the mean times of usage, 10, the result is 12 250, as can be seen in the table 19. The HD boxes are only used for night deliveries to the dealers in the Maastricht area, therefore only the order lines for the night deliveries from the LDC are used in the analysis. The last column in table 19 shows the number of average order lines per box, which for HD boxes is 24, this calculation is based on the proportion between order lines and adjusted number of boxes. This number is difficult to analyze without knowing the exact volume of the order lines. The night delivery often consists of big orders where there are many products per order line. Additionally, the operators estimate the boxes to be full five out of ten times as mentioned in the section 4.3.2.2 Tertiary packaging. However, this is not enough to investigate the average number of order lines per box, and therefore this should be further investigated by the company.

When looking at the One Way boxes in the same table 19, we can see that there are 780 boxes that are ordered, and this number will not be adjusted in the next column because it is not reused in Maastricht. The number of order lines is 186 628. The order lines that are included in the table for One Way boxes are the order lines from the SDC, because the One Way boxes are only used for deliveries to France. The relation between order lines and number of boxes is calculated to 239. Because the exact number of orders that fit a tertiary packaging is not known, it is difficult to say if this number is reasonable.

For the secondary packaging, a reference quantity was obtained to be used for a comparison of the order quantity and reference quantity. A correlating reference quantity for the tertiary packagings could not be gathered. Without this data, it is difficult to further investigate the data in table 19 and determine if the ordering of tertiary packagings correlates to the usage.

	Number of boxes ordered	Adjusted number of boxes	Order lines	Order lines / number of ajusted boxes
HD	1 225	12 250	295 542	24
One Way	780	780	186 628	239

Table 19: Number of tertiary packaging in relation to order lines.

5.3.2 Number of packaging products

This section is divided into Reducing the number of packaging products, secondary packaging and tertiary packaging. In the section about reducing the number of packaging products, an analysis will be conducted whether or not it is possible to reduce the number of products as well as the reasons why the product numbers should be decreased. In the sections Secondary packaging and Tertiary packaging, the analysis will investigate the possibility of eliminating products within each category.

5.5.2.1 Reducing the number of packaging products

As mentioned in the section Mapping; packaging orders, the process for choosing which products that should be used for an order, can be seen as a waste. If the number of packaging products can be reduced, this waste can decrease. Another reason for reducing the number of products is because it costs to hold products in the Web-PULS and have them in the inventory, which is a waste, as mentioned in the section, Mapping; Inventory: Storage. Furthermore, the products take up storing locations, and therefore space, in the stocking area, as can be seen as a waste.

5.5.2.2 Secondary packaging

In this section, the secondary packaging will be investigated to see if it is possible to reduce the number of products within this category. According to previous reasoning in section 4.4.2.1, Blue boxes will not be part of the analysis because of insufficient data. The section will therefore be divided into Cardboard boxes and plastic bags.

Cardboard boxes

Previously in section 4.4.2.1 Number of packaging products, tables regarding order quantity and volume for the Cardboard boxes have been presented. These will be the base for the analysis. The different products are grouped in different intervals regarding volume. To not reduce too many sizes regarding volume, the products within the interval should be comparable and able to fit orders of various contents and volumes. The range of intervals that have been chosen is 5 000 cm^3 because this was considered a suitable range when looking at the boxes' sizes and order quantity in relation to each other.

One product from each group will be selected to represent the group, and the rest will be eliminated. Both volume and order quantity will be taken into consideration when reducing the number of packaging products. In figure 34, the Cardboard boxes are visualized in a diagram that shows both volume and order quantity. As can be seen, there are two products that stand out among the others which are colored red. These products are clearly alone in their intervals and will not be eliminated. The fact that these products are so much greater in volume, makes it difficult to see the other Cardboard boxes' volumes and order quantities. Therefore, a new figure 35 has been made to show the Cardboard boxes with a volume under 90 000 cm^3. In this figure the intervals are shown as well.

The Cardboard boxes that are chosen in their intervals are:

- 5925576
- 509748
- 6766207
- 509753
- 513542
- 513537
- 540403 *
- 509722

* Both product number 509732 and 540403 have the same order quantity and are in the same interval. Product number 540403 was chosen because it is in the middle of the interval.

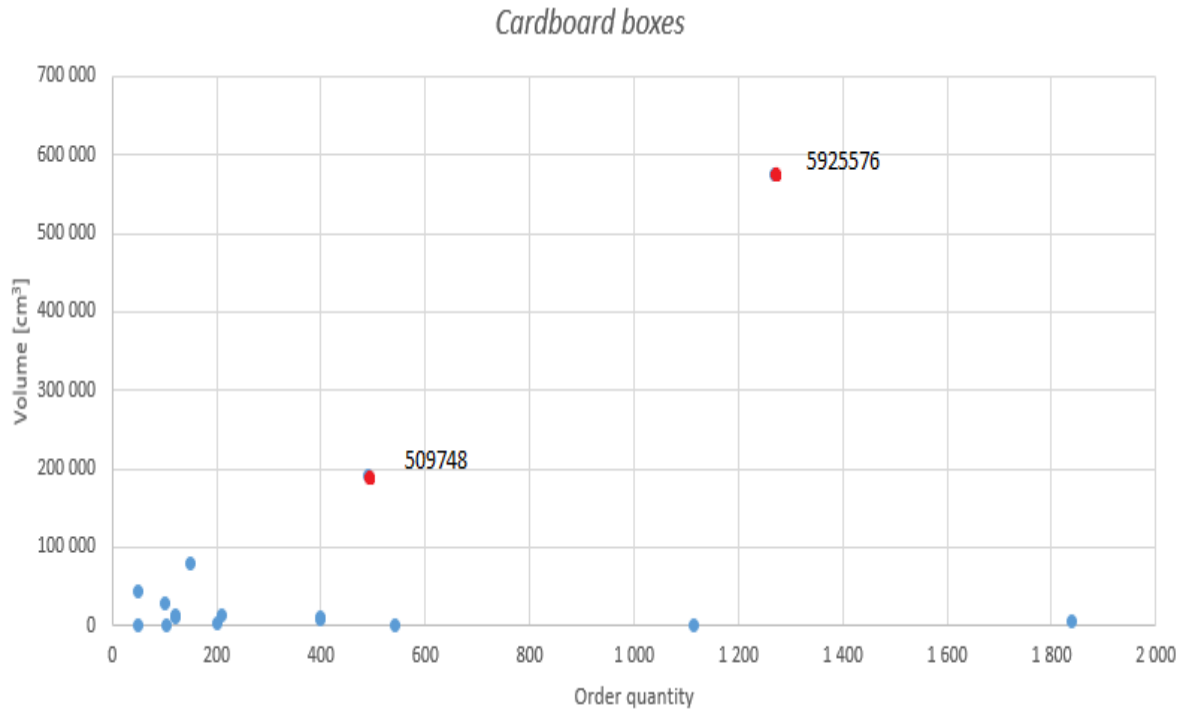
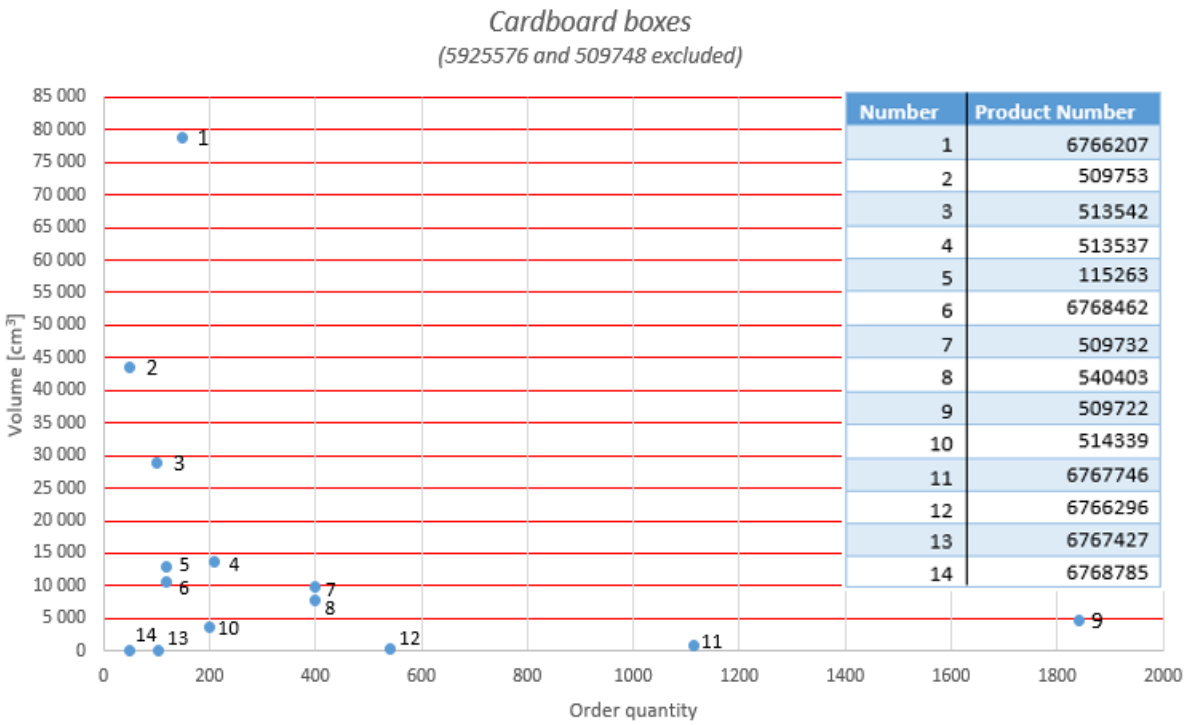


Figure 34: A diagram of the relation between volume and order quantity for the cardboard boxes. The red dots represent the two products that will be chosen from this diagram and therefore not be included in the next diagram. The reasons for this is presented in the text.



Number	Product Number
1	6766207
2	509753
3	513542
4	513537
5	115263
6	6768462
7	509732
8	540403
9	509722
10	514339
11	6767746
12	6766296
13	6767427
14	6768785

Figure 35: The volume and order quantity of the Cardboard boxes displayed in a diagram, categorized in groups based on volume, except Cardboard boxes with product numbers 5925576 and 509748. The red lines represent the limits of the intervals.

Plastic bags

Previously in section 4.4.2.1 Number of packaging products, tables regarding order quantity and volume for the plastic bags have been presented. These will be the base for the analysis as well. The different products are grouped in different intervals regarding volume. To not reduce too many sizes regarding volume, the products within the interval should be comparable and able to fit orders of various contents and volumes. On the other hand, the plastic bags have the favorable characteristic that even if the packaging is a bit too big, it will not take up a lot of extra space in the tertiary packaging, and therefore the different volumes of packaging can be further reduced. The range of intervals that have been chosen is 2,5 cm^3, because this was considered a suitable range when looking at the plastic bags' sizes and order quantity in relation to each other.

One product from each group will be selected to represent the group, and the rest will be eliminated. Both volume and order quantity will be taken into consideration when reducing the number of packaging products. In table 36 the plastic bags are visualized in a diagram that shows both volume and order quantity, as well as the chosen intervals. One plastic bag from each interval will be chosen; the plastic bag with the highest order quantity in each interval will be selected and the other eliminated.

The products that have been selected in respective group are:

- 6767801(2)
- 6767803(4)
- 6767804(5)
- 6767806(7)
- 6767807(8)

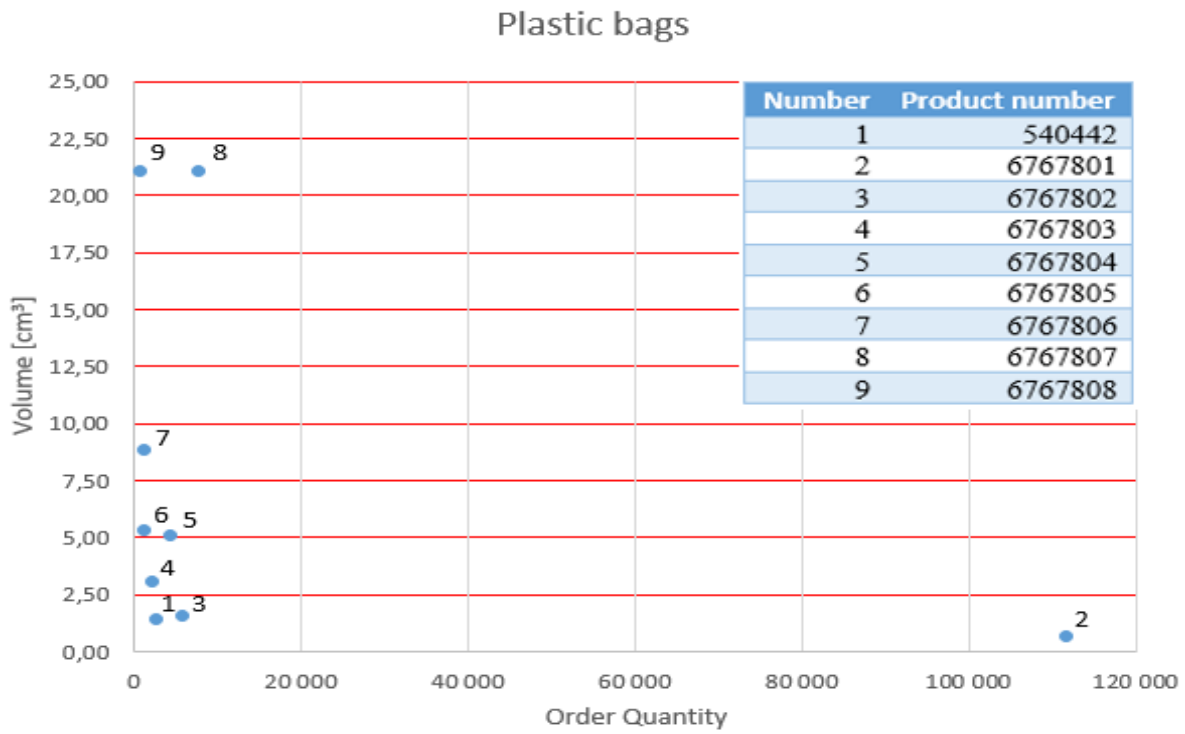


Figure 36: The volume and order quantity of the plastic bags displayed in a diagram, categorized in groups based on volume. The red lines represent the limits of the intervals.

5.5.2.3 Tertiary packaging

The tertiary packaging consists of one size of One way box and one size HD box. These two different boxes are of different sizes which fit the demand of orders. Therefore, it would be unfavourable to eliminate one type of box completely and only use one size of the boxes. However, since the HD boxes consist of fewer parts, a possible alternative would be to change the One Way box to a HD box of the same size, F4. This would reduce the total number of different products in the system. A consequence of this, would be to implement a working return flow from France to Maastricht. The implementation of a return flow will be further debated in the discussion chapter.

6 DISCUSSION

This chapter is divided into three different sections Discussion based on research questions, Conclusive discussion and Research questions check point. The section about research questions will discuss areas in the thesis with the research questions as a base. This will be followed by a conclusive discussion of the research questions. Lastly, an overview of where in the thesis the answers to the questions can be found will be presented.

6.1 Discussion based on research questions

This section will further discuss the results of this thesis as well as how the results have been reached with the research questions as a base.

6.1.1 How is the current packaging flow, both regarding physical and information, structured?

This question is investigated by a mapping of the processes connected to the packaging flow. The mapping is made to give an overview of the flow and does not go into a high level of detail. It informs of positive aspects as well as areas that need improvement. This level of detail is considered to be sufficient for the purpose of the thesis, however the mapping can be conducted on a deeper level to give a better understanding, now that the problem areas have been pointed out. Furthermore, the observations of the flow of packaging products to France has only been based on data gathered in Maastricht. Therefore, the processes after the packaging products leaves Maastricht is not at the same level of detail. The time period of observations and interviews in Maastricht was also limited which can affect the results.

An area with need of improvement that has been identified in the packaging flow, is the information connected to the process of reporting the usage of packaging products as well as the number of products in inventory. The operators usually observe the inventory of packaging products and send an email to the ESC when more packaging products are needed. Since there is a system, web-PULS, for this process, the emailing results in double work for both operators in Maastricht and external stock controllers. If the reporting of the usage in web-PULS could be made more continuously, the system would take care of the ordering of new packaging products and decrease the workload.

An example of how the updating of inventory can be made more continuous is presented as follows. The operators do not report in web-PULS what types of secondary packaging that is used for an order. However, the operators fill in a case number of the packaging product they have used for the order, on a label, which is printed out and put on the packaging. This system can either be integrated with web-PULS or an extra working procedure can be added to also update the usage in web-PULS. This can lead to improved control of the flow and a standardized process regarding ordering of packaging products, for example refill by order point, which will decrease the workload.

Another area of improvement that has been identified is the return flow. Both the return flow from dealers in Maastricht and France can be improved and better utilized. One aspect is that the flow of returning packaging products have not been controlled which has lead to that the LDC in Maastricht has been getting packaging products that they do not use and therefore have to throw away. This mostly occurs regarding the returns from France. This means that the used packaging products has been transported from France to Maastricht, only to be thrown away, which is wasteful. Another aspect is that the packaging products that have been returned that Maastricht want to reuse, are not sorted. This is the case with the Blue boxes from dealers in Maastricht. This has led to time-consuming work with the process of separating the different products from each other.

To increase efficiency of the return flow, standardization of what packaging products that should be sent back, and how it should be sent, can be made. If the packaging products that should be reused in Maastricht are determined and then communicated out to the dealers, Maastricht would not get returns of packaging products that they do not reuse, and therefore require to be thrown away. Furthermore, if a system of how the returns should be delivered is designed, the problem of sorting out the returned packaging products could be solved. For example, the employees at the dealers could be instructed to sort out the different packaging products directly after using them. This leads to that the packaging products are already sorted when returning to Maastricht and the operators would save the time they would otherwise put on separating them.

The return flow from dealers in the Maastricht area is fairly developed, and these suggestions would not generate very much work. The return flow from France however, would require more effort to improve because it is not as developed as the return flow in the Maastricht area. Furthermore, there are also costs connected to the implementation of a return flow that should be further investigated such as transport costs, operational costs and administrative costs. With operational costs, the additional work that comes with the return flow is intended, for example the salaries of the operators that will handle the packaging products that are returned. However, a positive aspect is that the transport from France already exists, only that it is not used for returns of packaging products. To implement a working system for the return flow for packaging products from France would lead to the possibility to send returnable packaging to France.

6.1.2 What are the different types of packaging that are used in the LDC in Maastricht and how are they used?

When collecting data about the usage of the different types of packaging products, the methods observations and interviews were used. These methods gave a good overview of the different usage and types of packaging products. However, further investigation can be conducted regarding a longer time period of observations and more interviews with a larger amount of operators. Different packaging products are used depending on the different markets which have different needs, therefore when deciding which packaging products that are the most beneficial, the different needs should be further investigated.

In this thesis the current state in Maastricht have been investigated, which leads to that there is a limited amount of packaging types that have been investigated. To get a better understanding of which packaging product type that is most beneficial, the investigation should also include different usage of different packaging products types at a larger amount of LDC's. However, the selected LDC in Maastricht has been considered representative for the packaging products of spare parts distribution which contributes to that the findings of this thesis are still valid.

The data collection regarding the secondary packaging types has identified that the Blue boxes are the most beneficial, regarding different aspects comparing benefits and disadvantages with the Cardboard boxes and plastic bags. Moreover, the Blue boxes are easy to handle both regarding usage and the ergonomic aspects, and they are reusable which is beneficial in an environmental point of view. However, it is not possible to eliminate the other secondary packaging types, because they have other beneficial functions. The Cardboard boxes are more stable which makes them better to use when there are fragile, heavy or dangerous spare parts. However, a further investigation should be conducted to analyze if it is possible for the Blue boxes to replace the Cardboard boxes regarding these functions. Moreover, the plastic bags are beneficial because the plastic can adjust to the spare parts which leads to that it takes up less space when transported and fit several different spare parts' shapes. In addition, the plastic bags are transparent that makes it possible to see the plastic bags' content, which is beneficial for operators and employees at the dealers.

The data collection regarding the tertiary packaging types has identified that the HD boxes are the most beneficial regarding different aspects comparing benefits and disadvantages with the One Way packaging. Operators at the LDC prefer the HD boxes over the One Way boxes because of easier handling. The employees at the dealer favor them because they do not need to handle the disposal process because they are reusable and sent back to the LDC after being used. The fact that they are reusable also makes the HD boxes a better choice from an environmental point of view. Furthermore, the ergonomic aspects of the boxes will be further discussed below.

The tertiary packaging products are always of the same height, which leads to ergonomic problems in form of bending over the packaging product when packing and unpacking the orders. However, the One Way boxes are always of the same height, but the HD boxes consist of collars that can easily be removed, which makes it possible to reduce the height of the box. Moreover, this solution is never used at the LDC. A possible working procedure to decrease the ergonomic problems, can be that the operators use the right amount of collars for the degree of filling of the box. For example, when starting to fill the box with orders, only one collar is placed on the pallet, and when the box is starting to get full, the operators place a new collar on the first collar. The same procedure can be conducted when unpacking the orders, so that when the degree of filling decrease, the employee at the dealer removes one collar, and the procedure keep on going. This working procedure would decrease the ergonomic problems, both for the operators at the LDC and the employees at the dealer.

However, it is not possible to eliminate the One Way boxes, because the One Way boxes are used for delivery to France, which currently have no working return flow for packaging products. If

the HD boxes are implemented for deliveries to France, when there is no working return flow, they lose their beneficial environmental aspects. There is also a cost connected to a working return flow. The amount of this cost has not been investigated in this thesis. However, the cost can be in form of extra transport, sorting and storing the reused packaging products. Furthermore, this discussion leads to the cost aspect which is presented further below, in the section 6.2 Conclusive discussion.

6.1.3 How is the cost of packaging products related to the packaging usage?

This question is investigated by collecting data in form of interviews and order history, which gives the quantity and the cost of the different packaging products. Regarding the data concerning order history, notes should be taken that the time period of which the order history is investigated can be longer and that the inventory before and after the period is unknown, which is important to keep in mind when interpreting the results. To get a better view of the usage a longer time period can be applied and by a better control of the inventory a deeper analysis of the usage can be made.

However, this data indicates which packaging products are the most economical. Comparing the secondary packaging products with each other, the plastic bags are beneficial regarding cost. Moreover, comparing the tertiary packaging with each other, the HD boxes are most economical both for deliveries in the Maastricht area and for deliveries to France, if it is possible to reuse this packaging at least once.

A comparison of the reference quantity and the order history is made, as well as a comparison of the estimated usage and the order history. These comparisons result in an overview of the difference between what should be ordered and what have been ordered. The result is that the LDC orders less than expected. Reasons for this can be that the packaging is reused more than have been estimated or that the inventory before and after is not taken into consideration in this thesis. This can be further investigated to get a better understanding of the usage.

When investigating the number of secondary packaging products, the result is that some of the packaging products are in similar sizes, regarding volume. To decrease the number of products is beneficial, because it can result in an improved standard working process, fewer products to be managed in web-PULS, less work with purchasing processes and decreased need of storage, which can lead to decreased costs. Therefore, a number of packaging products within the secondary category have been chosen to represent the category based on volume and order quantity. One aspect to take into consideration before removing some of the packaging products is that the packaging product can have different shapes, even if they are of the same volume. For example, a packaging product of the same volume can be of different shapes and dimensions regarding height and width. This should be further investigated before reducing some of the secondary packaging products. For the tertiary packaging the HD boxes consist of fewer parts and therefore is the most preferable compared to the One Way box, regarding reducing the number of packaging products.

6.2 Conclusive discussion

From the discussion above, some conclusions have been drawn and will be presented as follows.

For secondary packaging, the plastic bags are most beneficial. However, plastic bags do not have the same protective qualities as the Blue boxes and Cardboard boxes. Therefore, for day deliveries Blue boxes are preferable because the orders are not protected by a tertiary packaging. The Blue boxes are chosen over the Cardboard boxes because they are more economical. This have to be further investigated by the company to see if the Blue boxes can be used to replace the Cardboard boxes. For tertiary packaging, the HD boxes are most beneficial.

However, these suggestions require working return flows to be advantageous. The return flows can be implemented with restrictions regarding what packaging products should be in circulation and how the packaging products should be handled in the returning process to increase efficiency. The costs of improving the return flows have to be further investigated by the company. Example of costs that are added when implementing a return flow are operational costs, transport costs and administrative costs. With operational costs, the additional work that comes with the return flow is intended, for example the salaries of the operators that will handle the packaging products that are returned. This can for example be the sorting process that the operators conduct regarding the returned Blue boxes. A solution for this problem is to instruct the employees at the dealer to sort the packaging products before returning them.

Concerning the transport costs, there is already a return flow from France that is intended for spare parts, which sometimes is used for returnable packaging as well. Furthermore, the returnable packaging products are the most beneficial, both regarding cost and the most prefered packaging products by operators and employees at the dealer. With these factors in mind, it can be profitable to get a standardized working return flow from France concerning returnable packaging.

Furthermore, the information flow is not sufficient to control the packaging flow and generates extra work. To get better control of the flow and stock levels, continuous updates of the inventory should be made in web-PULS. A suggestion of how this can be made is found in section 6.1.1 How is the current packaging flow, both regarding physical and information, structured? This process can be easier to implement if the number of packaging products is reduced. These suggestions can lead to an improved standardized working procedure and better control of the flow of packaging products.

6.3 Research Questions Check Point

- How is the current packaging flow, both regarding physical and information, structured?

The structure of the packaging flow can be seen in the current state maps in appendix 10.1, 10.2 and 10.3 and in the correlating description in section 4.2 Current State Map.

- What are the different types of packaging that are used in the LDC in Maastricht and how are they used?

The different types of packaging that are used in the LDC in Maastricht is presented in section 4.3 Packaging procedures. There is also information about how and when they are used. Additional information can be found in section 4.2 Current State Map.

- How is the cost of packaging products related to the packaging usage?

The different costs of packaging that are used in the LDC in Maastricht is presented in section 4.4 Usage of packaging products. There is also information about the order quantity and the number of packaging products.

7 CONCLUSION

This thesis has investigated the usage of packaging products for spare parts in the LDC in Maastricht. The investigation consists of mapping of the current state, examination of the packaging products that are used and a study of the costs and ordering process connected to the packaging flow.

The mapping of the packaging flow showed that improvements regarding the information flow as well as the return flow can be made.

The investigation regarding the different packaging types showed that for the secondary packaging, the Blue boxes were preferred by the operators and was easy to handle. For tertiary packaging the HD boxes was considered favorable among the operators regarding ergonomic aspects. From an economical perspective the plastic bags are advantageous for the secondary packaging respective the HD boxes for the tertiary packaging.

The ordering of packaging was less than expected if compared to a reference quantity. A possible reason for this is that some of the packagings can be reused, which can lead to a misleading estimation regarding number of times the packaging can be reused. Furthermore, the inventory before and after the time period of the thesis is unknown which also can contribute to a possible error source.

Moreover, some of the secondary packaging products have volumes that are similar in size, therefore, it is possible to reduce some of the packaging products. Furthermore, the packaging products can have different shapes and should therefore be further investigated.

The approaches chosen to investigate the usage of packaging in Maastricht have been sufficient for the purpose of the thesis.

8 RECOMMENDATIONS FOR THE COMPANY

Recommendations regarding the return flow in the Maastricht area include instructing the employees at the dealer to sort the returnable packaging products before sending them back to the LDC.

The company is also recommended to investigate the possibility to increase the usage of the return flow from France, that is currently only used for returns of spare parts. The recommendation concerns an implementation where the current flow is integrated with returns of packaging products as well. For this implementation to be profitable, it is recommended to control which packaging products that should be in circulation and how these packaging products should be returned.

Regarding the information flow for packaging products, the recommendation is to improve the working procedures concerning updating the inventory, so that these processes become standardized and continuous. This will contribute to an improved control of the flow of packaging products.

Recommendations concerning the secondary packaging, include using the plastic bags when it is possible. The plastic bags can be used for ordinary orders that are not fragile, heavy or include dangerous goods. The plastic bags should not be used when the orders are sent without a tertiary packaging, in this case the day deliveries. Then the Blue boxes are recommended. The company is advised to investigate if it is possible to use the Blue boxes when the plastic bags are not possible to use and thereby replace the Cardboard boxes completely.

For the tertiary packagings, the company is advised to use HD boxes if there is a working return flow for packaging products. To decrease ergonomic problems, the operators at the LDC and the employees at the dealer can be instructed to put on collars as the content of the box increases, and remove collars when the content decreases.

The company is recommended to reduce the number of packaging products. For the secondary packaging this reduction is suggested to be based on volume and order quantity. The packaging products that are recommended to be used within each category is presented in section 5.5.2.2 Secondary packaging. However, this can not be seen as a final recommendation but have to be further investigated by the company regarding the shapes of the packaging products, as well as the operators' opinions.

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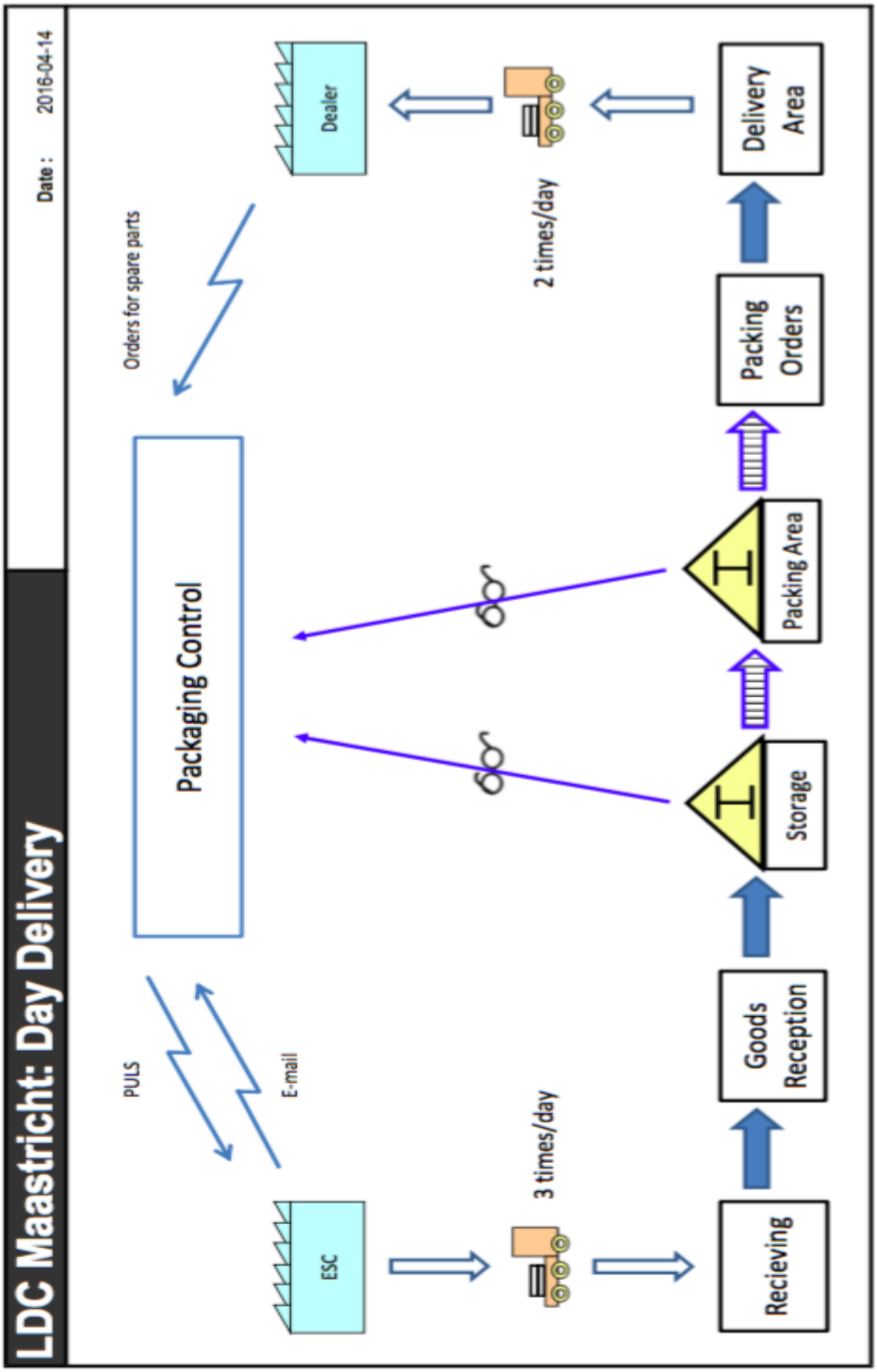
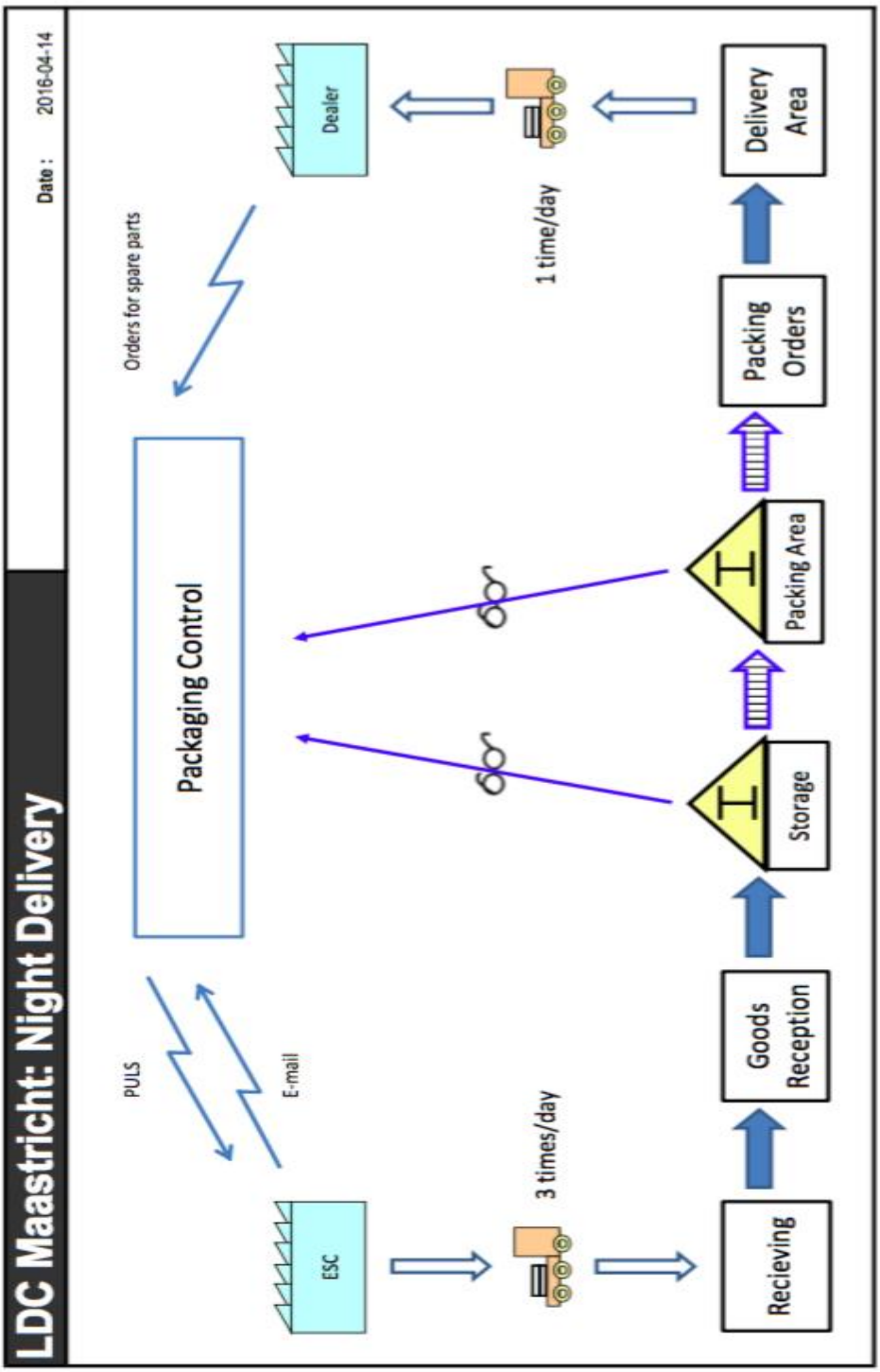
10 APPENDICES

In this chapter the appendices are presented.

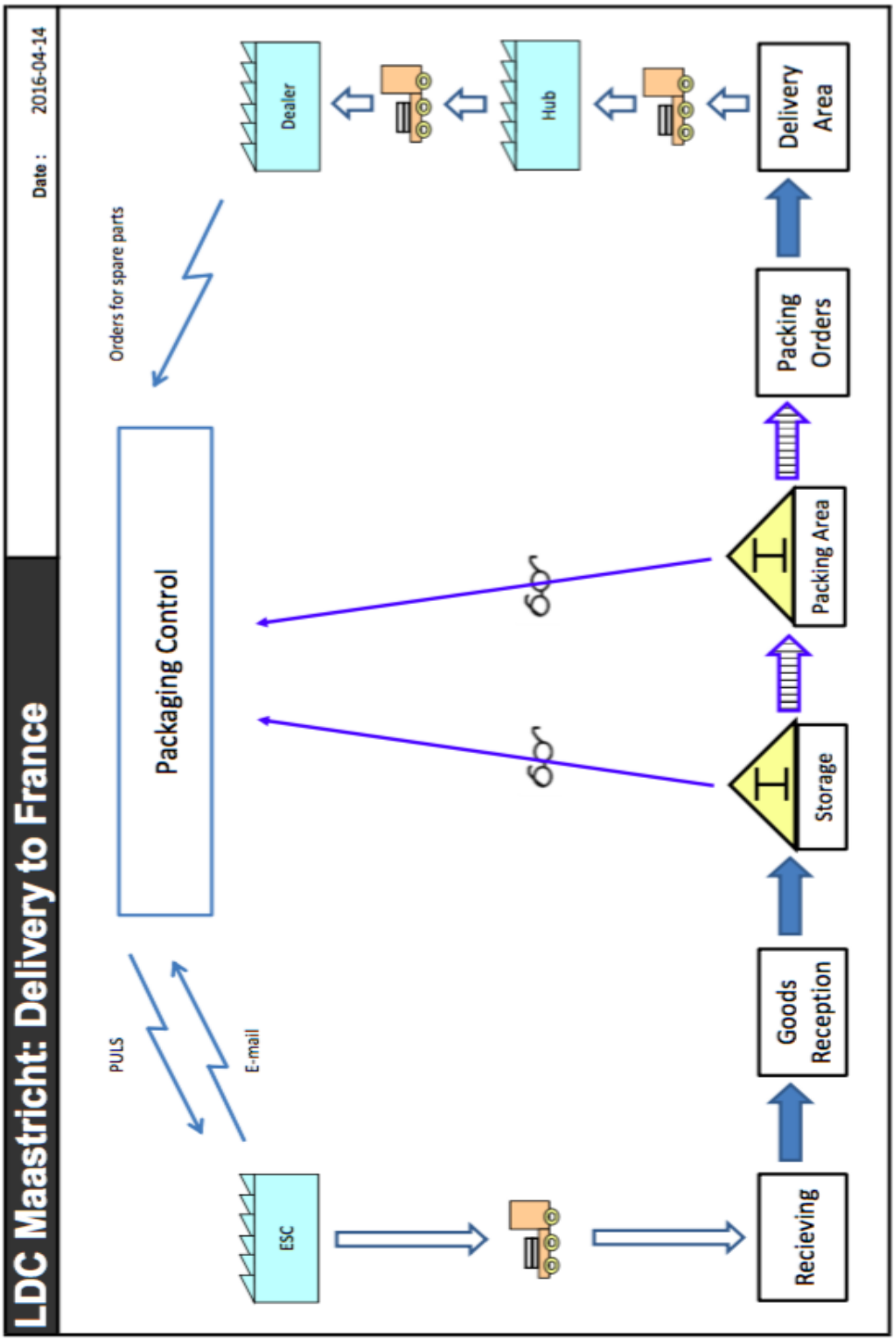
10.1 Current state map: Day



10.2 Current state map: Night



10.3 Current state map: France



10.4 Order history: Papyrus

Oder lines	Date	Part no	STK	Material Cost	Freight cost	Total invoiced
1	240815	6769107	200	15 086,00 kr		15 086,00 kr
2	240815				5 960,00 kr	5 960,00 kr
1	140815	3499040	259	14 781,13 kr		14 781,13 kr
2	140815	3498995	2 102	77 374,62 kr		77 374,62 kr
1	140815	3499176	291	13 257,96 kr		13 257,96 kr
2	140815	3499348	498	40 816,08 kr		40 816,08 kr
3	140815	3499330	521	22 246,70 kr		22 246,70 kr
						- kr
1	281215	3498506	2 010	16 281,00 kr		16 281,00 kr
2	281215	3498730	1 040	18 408,00 kr		18 408,00 kr
3	281215	3499330	485	20 709,50 kr		20 709,50 kr
4	281215				1 860,38 kr	1 860,38 kr
1	101215	6769067	156	10 015,20 kr		10 015,20 kr
2	101215	6769063	156	9 163,44 kr		9 163,44 kr
3	101215				2 406,80 kr	2 406,80 kr
1	281015	6769063	156	9 163,44 kr		9 163,44 kr
2	281015	6769067	156	10 015,20 kr		10 015,20 kr
3	281015				2 476,13 kr	2 476,13 kr
1	011015	3498680	990	21 651,30 kr		21 651,30 kr
2	011015				1 866,00 kr	1 866,00 kr
1	100915	6769067	156	10 015,20 kr		10 015,20 kr
2	100915	6769063	156	9 163,40 kr		9 163,40 kr
3	100915				2 217,00 kr	2 217,00 kr
1	280815	3499330	670	29 332,38 kr		29 332,38 kr
1	130815	3498602	936	11 007,36 kr		11 007,36 kr
2	130815	3498603	924	17 269,56 kr		17 269,56 kr
1	120815	3498692	896	32 166,40 kr		32 166,40 kr
2	120815	3499147	260	14 801,80 kr		14 801,80 kr
3	120815	3499433	544	20 623,04 kr		20 623,04 kr
1	140815	6769067	208	13 353,60 kr		13 353,60 kr
2	140815	6769063	78	4 581,72 kr		4 581,72 kr
3	140815	6769063	130	7 636,20 kr		7 636,20 kr
1	050815	6769140	200	17 544,00 kr		17 544,00 kr
1	050815	6769140	150	13 444,01 kr		13 444,01 kr
2	050815				46 233,57 kr	46 233,57 kr
1	050815	3498506	2 120	17 495,44 kr		17 495,44 kr
2	050815	3499330	530	23 191,63 kr		23 191,63 kr
3	050815	3499524	520	10 329,14 kr		10 329,14 kr
4	050815	3498624	504	14 315,71 kr		14 315,71 kr
5	050815	3499355	960	22 938,30 kr		22 938,30 kr
1	230715				4 751,25 kr	4 751,25 kr
1	160715	3499330	557	23 783,90 kr		23 783,90 kr
1	300715	3498506	2 320	19 099,17 kr		19 099,17 kr
2	300715	3498624	535	15 187,36 kr		15 187,36 kr
3	300715	3499355	1 135	27 064,72 kr		27 064,72 kr
4	300715	3499524	520	10 283,88 kr		10 283,88 kr
1	130715	3498901	520	38 079,60 kr		38 079,60 kr
2	130715	3498936	1 485	29 477,25 kr		29 477,25 kr

3	130715	3498506	1 920	15 552,00 kr		15 552,00 kr
4	130715				1 854,16 kr	1 854,16 kr
1	140715	6769063	104	6 108,96 kr		6 108,96 kr
2	140715	6769067	104	6 676,80 kr		6 676,80 kr
3	140715				2 772,00 kr	2 772,00 kr
1	130715	6769034	180	6 112,80 kr		6 112,80 kr
2	130715	6769113	400	6 472,00 kr		6 472,00 kr
3	130715	6769063	195	11 454,30 kr		11 454,30 kr
4	130715	MISSING	1	183,00 kr		183,00 kr
1	010715	6769141	100	6 214,00 kr		6 214,00 kr
2	010715				2 960,00 kr	2 960,00 kr
1	290615	5925576	150	12 343,50 kr		12 343,50 kr
2	290615	5925576	225	18 515,25 kr		18 515,25 kr
1	240615	3499524	497	9 626,89 kr		9 626,89 kr
2	240615	3499355	295	6 885,30 kr		6 885,30 kr
3	240615	3498995	1 800	66 258,00 kr		66 258,00 kr
4	240615				1 865,34 kr	1 865,34 kr
1	240615	6769113	600	9 520,30 kr		9 520,30 kr
2	240615				18 494,00 kr	18 494,00 kr
1	240615	6769113	700	11 326,00 kr		11 326,00 kr
2	240615				2 235,38 kr	2 235,38 kr
1	180615	6769107	50	3 771,50 kr		3 771,50 kr
2	180615				4 145,00 kr	4 145,00 kr
1	180615	3498730	995	17 611,50 kr		17 611,50 kr
1	180615	3499355	720	16 804,80 kr		16 804,80 kr
2	180615				8 466,30 kr	8 466,30 kr
1	220615	6769063	104	6 108,96 kr		6 108,96 kr
2	220615	6769067	104	6 676,80 kr		6 676,80 kr
3	220615				2 593,13 kr	2 593,13 kr
1	120615	3498680	1 063	23 247,81 kr		23 247,81 kr
2	120615				1 859,02 kr	1 859,02 kr
1	170615				4 586,10 kr	4 586,10 kr
2	170615				4 586,10 kr	4 586,10 kr
3	170615				4 586,10 kr	4 586,10 kr
1	120615	3498624	500	13 781,34 kr		13 781,34 kr
2	120615	3499355	1 034	24 019,91 kr		24 019,91 kr
3	120615	3498901	250	18 206,12 kr		18 206,12 kr
4	120615	3499348	246	2 169,72 kr		2 169,72 kr
5	120615	3498506	2 122	1 846,14 kr		1 846,14 kr
6	120615	3498680	997	21 597,99 kr		21 597,99 kr
7	120615	3498936	1 565	30 872,97 kr		30 872,97 kr
8	120615	3499433	536	20 159,29 kr		20 159,29 kr
1	150615	6769036	500	11 563,88 kr		11 563,88 kr
2	150615	6768987	150	19 149,23 kr		19 149,23 kr
3	150615				66 446,40 kr	66 446,40 kr
1	100615	MISSING	420		5 712,00 kr	5 712,00 kr
1	090615	6769141	150	993,00 kr		993,00 kr
2	090615				52 830,19 kr	52 830,19 kr
1	100615	6768984	210	29 823,07 kr		29 823,07 kr
2	100615	6769063	195	11 427,64 kr		11 427,64 kr

1	250515	3498730	1 065	18 701,48 kr		18 701,48 kr
2	250515	3499330	553	23 459,06 kr		23 459,06 kr
3	250515	3498994	264	17 494,27 kr		17 494,27 kr
1	220515	6769068	104	8 497,84 kr		8 497,84 kr
2	220515	6769062	104	3 579,68 kr		3 579,68 kr
3	220515				2 347,00 kr	2 347,00 kr
4	220515	MISSING	3	549,00 kr		549,00 kr
1	180515	3499348	254	20 817,84 kr		20 817,84 kr
1	200515	3499443	2 970	27 599,67 kr		27 599,67 kr
2	200515				13 803,46 kr	13 803,46 kr
1	130515	3498994	264	17 624,64 kr		17 624,64 kr
2	130515	3498901	248	18 161,04 kr		18 161,04 kr
3	130515	3498624	520	14 430,00 kr		14 430,00 kr
1	110515	6769142	50	2 768,50 kr		2 768,50 kr
2	110515				2 095,00 kr	2 095,00 kr
1	080515	3499524	480	9 266,93 kr		9 266,93 kr
2	080515	3499176	296	13 472,11 kr		13 472,11 kr
1	110515	6769113	200	3 236,00 kr		3 236,00 kr
2	110515				1 172,25 kr	1 172,25 kr
1	110515	6769113	600	9 708,00 kr		9 708,00 kr
2	110515				156,67 kr	156,67 kr
3	110515	6769113	100	1 618,00 kr		1 618,00 kr
4	110515				782,33 kr	782,33 kr
1	290415	3498603	924	17 247,90 kr		17 247,90 kr
1	240515	6769036	375	8 872,50 kr		8 872,50 kr
2	240515				1 650,00 kr	1 650,00 kr
1	280415	6769063	195	11 454,30 kr		11 454,30 kr
2	280415				2 664,53 kr	2 664,53 kr
3	280415	MISSING	1	105,00 kr		105,00 kr
1	230415	6769107	200	15 086,00 kr		15 086,00 kr
2	230415				5 077,00 kr	5 077,00 kr
1	220415	6769141	800	49 712,00 kr		49 712,00 kr
2	220415				3 600,00 kr	3 600,00 kr
1	200415	3498730	1 450	24 871,98 kr		24 871,98 kr
2	200415	3498506	2 120	16 630,74 kr		16 630,74 kr
3	200415	3499330	492	20 361,66 kr		20 361,66 kr
4	200415	3498936	1 550	29 819,83 kr		29 819,83 kr
5	200415	3498624	480	12 908,18 kr		12 908,18 kr
6	200415	3499355	900	20 354,06 kr		20 354,06 kr
7	200415	3498504	535	12 211,97 kr		12 211,97 kr
8	200415	3499147	241	13 296,19 kr		13 296,19 kr
9	200415	3498901	235	16 676,89 kr		16 676,89 kr
10	200415	3498995	2 120	75 832,02 kr		75 832,02 kr
1	210415	6769142	150	7 650,00 kr		7 650,00 kr
2	210415				5 752,00 kr	5 752,00 kr
1	200415	6769414	250	15 535,00 kr		15 535,00 kr
2	200415				3 700,00 kr	3 700,00 kr
1	220415	6769113	50	809,00 kr		809,00 kr
2	220415	6769061	52	1 626,56 kr		1 626,56 kr
3	220415	6769067	52	3 338,40 kr		3 338,40 kr

4	220415				1 951,74 kr	1 951,74 kr
1	220415	6768986	290	15 126,40 kr		15 126,40 kr
2	220415	6769034	480	16 300,80 kr		16 300,80 kr
3	220415	6769061	520	16 265,80 kr		16 265,80 kr
4	220415				6 355,68 kr	6 355,68 kr
1	170415	6769036	480	10 296,00 kr		10 296,00 kr
2	170415	6768987	200	2 560,00 kr		2 560,00 kr
3	170415				16 000,00 kr	16 000,00 kr
1	210415	6769113	70	11 102,00 kr		11 102,00 kr
2	210416	6769063	299	17 219,41 kr		17 219,41 kr
3	210417	6769067	520	31 122,00 kr		31 122,00 kr
4	210418				6 355,86 kr	6 355,86 kr
5	210419	MISSING	1	105,00 kr		105,00 kr
6	210420	MISSING	10	1 830,00 kr		1 830,00 kr
7	210421	MISSING	11	1 144,00 kr		1 144,00 kr
8	210422	MISSING	2	210,00 kr		210,00 kr
1	080415	6769067	520	31 122,00 kr		31 122,00 kr
2	080415				5 694,46 kr	5 694,46 kr
1	070415	6769036	480	10 296,00 kr		10 296,00 kr
2	070415				3 206,00 kr	3 206,00 kr
3	070415	MISSING	2	122,20 kr		122,20 kr
1	190315	3498936	1 564	29 773,64 kr		29 773,64 kr
1	160315	3498995	1 998	70 869,88 kr		70 869,88 kr
2	160315	3499147	248	13 567,89 kr		13 567,89 kr
3	160315	3498504	509	1 238,76 kr		1 238,76 kr
1	200315	6769034	420	13 419,00 kr		13 419,00 kr
2	200315				2 421,17 kr	2 421,17 kr
3	200315	MISSING	4	532,00 kr		532,00 kr
1	170315	6769142	300	15 300,00 kr		15 300,00 kr
2	170315				4 286,00 kr	4 286,00 kr
3	170315	MISSING	12	879,00 kr		879,00 kr
1	170315	3499040	264	14 288,15 kr		14 288,15 kr
2	170315	3498692	948	32 273,38 kr		32 273,38 kr
3	170315	3498680	763	15 826,56 kr		15 826,56 kr
4	170315	3499036	275	19 830,87 kr		19 830,87 kr
1	120315	6769141	300	17 940,00 kr		17 940,00 kr
2	120315				2 270,00 kr	2 270,00 kr
1	110315	3499330	520	21 002,38 kr		21 002,38 kr
2	110315	3498730	1 050	17 577,12 kr		17 577,12 kr
3	110315	3499036	247	17 766,13 kr		17 766,13 kr
1	110315	6769058	520	31 122,00 kr		31 122,00 kr
2	110315	6768986	360	17 676,00 kr		17 676,00 kr
3	110315				7 082,00 kr	7 082,00 kr
4	110315	MISSING	10	1 830,00 kr		1 830,00 kr
5	110315	MISSING	3	657,00 kr		657,00 kr
1	100315	3498901	151	16 818,77 kr		16 818,77 kr
2	100315	3498680	240	4 982,82 kr		4 982,82 kr
1	040315	6768987	240	30 720,00 kr		30 720,00 kr
2	040315				13 818,00 kr	13 818,00 kr
1	230215	6769061	1 040	30 576,00 kr		30 576,00 kr

2	230215	6769063	598	34 438,82 kr		34 438,82 kr
3	230215	6769063	600	9 516,00 kr		9 516,00 kr
4	230215	6769058	208	12 448,80 kr		12 448,80 kr
5	230215	6768984	240	32 320,80 kr		32 320,80 kr
6	230215	6769034	480	15 336,00 kr		15 336,00 kr
7	230215				10 506,02 kr	10 506,02 kr
8	230215	MISSING	4	876,00 kr		876,00 kr
9	230215	MISSING	8	1 464,00 kr		1 464,00 kr
10	230215	MISSING	2	210,00 kr		210,00 kr
11	230215	MISSING	33	3 432,00 kr		3 432,00 kr
1	130215	3498506	2 129	17 074,50 kr		17 074,50 kr
2	130215	3498624	550	15 121,01 kr		15 121,01 kr
3	130215	3499355	1 040	24 045,74 kr		24 045,74 kr
1	130215	6769061	520	15 288,00 kr		15 288,00 kr
2	130215				2 347,01 kr	2 347,01 kr
3	130215	MISSING	5	915,00 kr		915,00 kr
1	280115	3498602	936	11 046,83 kr		11 046,83 kr
1	300115	6769068	104	7 940,40 kr		7 940,40 kr
2	300115	6769062	104	3 374,80 kr		3 374,80 kr
3	300115	6769063	104	5 989,36 kr		5 989,36 kr
4	300115				2 438,01 kr	2 438,01 kr
1	280115	6769061	104	3 057,60 kr		3 057,60 kr
2	280115	6769063	104	5 989,36 kr		5 989,36 kr
3	280115	6769067	104	6 224,40 kr		6 224,40 kr
4	280115				2 471,87 kr	2 471,87 kr
1	220115	6768984	300	40 401,00 kr		40 401,00 kr
2	220115				3 668,29 kr	3 668,29 kr
3	220115	MISSING	5	1 095,00 kr		1 095,00 kr
4	220115	6768986	320	15 712,00 kr		15 712,00 kr
5	220115				2 347,01 kr	2 347,01 kr
1	210115	6769142	200	10 200,00 kr		10 200,00 kr
2	210115				3 105,00 kr	3 105,00 kr
3	210115	MISSING	8	4 688,00 kr		4 688,00 kr
1	150115	6768987	150	19 200,00 kr		19 200,00 kr
2	150115	6769107	120	8 874,00 kr		8 874,00 kr
3	150115				13 916,00 kr	13 916,00 kr
1	150115	6769034	360	11 502,00 kr		11 502,00 kr
2	150115	6769061	312	9 172,80 kr		9 172,80 kr
1	090115	6769141	200	11 960,00 kr		11 960,00 kr
2	090116	MISSING	4	340,00 kr		340,00 kr
3	090115				4 600,00 kr	4 600,00 kr
				2 770 162,53 kr	411 402,71 kr	3 181 565,24 kr

10.5 Order history: ESC

SECONDARY

PN	Description	Total Oct-Mar	Cost per unit	Total cost
514334	Blue box	1 400	27,22 kr	38 108,00 kr
6769001	Blue box	150	52,06 kr	7 809,00 kr
	Blue box total	**1 550**		**45 917,00 kr**
509722	Carboard box	1840	2,52	102
509732	Cardboard box	400	5,12 kr	2 048,00 kr
509748	Cardboard box	490	57,66 kr	28 253,40 kr
509753	Cardboard box	50	20,84 kr	1 042,00 kr
513537	Cardboard box	210	7,32 kr	1 537,20 kr
513542	Cardboard box	100	13,44 kr	1 344,00 kr
514339	Cardboard box	200	4,38 kr	876,00 kr
540403	Cardboard box	400	3,64 kr	1 456,00 kr
1152639	Cardboard box	120	16,18 kr	1 941,60 kr
5925576	Cardboard box	1 269	87,60 kr	111 164,40 kr
6766207	Cardboard box	150	79,81 kr	11 971,50 kr
6766296	Cardboard box	542	105,37 kr	57 110,54 kr
6767427	Cardboard box	104	165,00 kr	17 160,00 kr
6767746	Cardboard box	1 113	91,39 kr	101 717,07 kr
6768462	Cardboard box	120	12,53 kr	1 503,60 kr
6768785	Cardboard box	50	9,48 kr	474,00 kr
	Cardboard box total	**7 158**		**339 701,31 kr**
540442	Plastic bag	3 000	0,30 kr	900,00 kr
6767801	Plastic bag	112 000	0,10 kr	11 200,00 kr
6767802	Plastic bag	6 000	0,22 kr	1 320,00 kr
6767803	Plastic bag	2 500	0,44 kr	1 100,00 kr
6767804	Plastic bag	4 500	0,72 kr	3 240,00 kr
6767805	Plastic bag	1 500	0,77 kr	1 155,00 kr
6767806	Plastic bag	1 500	1,03 kr	1 545,00 kr
6767807	Plastic bag	8 000	2,53 kr	20 240,00 kr
6767808	Plastic bag	1 000	1,69 kr	1 690,00 kr
	Plastic bag total	**140 000**		**42 390,00 kr**
	SECONDARY TOTAL	**148 708**		**428 008,31 kr**

PN	TERTIARY Description	Total Oct-N	Cost per unit	Total cost
	One Way:			
6768987	Pallet (F)	660	118,56 kr	78 249,60 kr
6768984	Outer Frame(F)	780	151,66 kr	118 294,80 kr
6769034	Inner frame (F)	1 560	36,15 kr	56 394,00 kr
6769036	Support plank (F)	1 155	25,19 kr	29 094,45 kr
6768986	Lid (F)	480	55,52 kr	26 649,60 kr
	One Way total	**4 635**		**308 682,45 kr**
	HD:			
6769140	Pallet (L)	450	93,38 kr	42 021,00 kr
6769141	Collar (L)	4 900	66,15 kr	324 135,00 kr
6769063	Lid (L)	156	62,53 kr	9 754,68 kr
6769142	Lid (L)	2 000	58,94 kr	117 880,00 kr
6769112	Pallet Spacer (L)	3 600	5,41 kr	19 476,00 kr
	HD total	**11 106**		**513 266,68 kr**
	TERTIARY TOTAL	**15 741**		**821 949,13 kr**
	LABELS			
5927425	Label	69	0,67 kr	46,23 kr
6768037	Label	490 000	0,24 kr	117 600,00 kr
6768343	Label	6 000	0,06 kr	360,00 kr
6768860	Label	735 000	0,03 kr	22 050,00 kr
	LABELS TOTAL	**1 231 069**		**140 056,23 kr**
	OTHER			
1150981	Product packaging	6	4,68 kr	28,08 kr
514371	Product packaging	50	5,45 kr	272,50 kr
	OTHER TOTAL	**56**		**300,58 kr**