School of Business, Economics & Law
Master Thesis in Logistics and Transport Management
Spring 2017

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Packaging Operations in the Automotive Industry

- *Revealing Operational Gaps Related to Network Inefficiency, using Volvo Cars Packaging Operations as an Example*

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Date: 2017-05-10

Abstract

The automotive industry has evolved into an industry of complex supply chains and networks, requiring many activities to be aligned and well-managed in order to avoid abnormalities in both the material flow and information flow. The car assembly requires many different components and material, which also in turn require different types of packaging when being transported to the production plants. This thesis has extended the limited research involving packaging operations of an automotive company, using Volvo Cars as an example. The study focuses on revealing possible gaps that could have a bad impact on the packaging operations and its network balance and flow. The coordination of the packaging requires a well-balanced network of suppliers, production plants, transportation and terminals, where also time management is of high significance as the market demand needs to be responded to. The striving towards efficiency in terms of reducing lead time is however not always flawless.

By using the SERVQUAL and CATWOE models as well as previous research, it was possible to reveal and conclude gaps within the organization in terms of communication both internally and externally. Also, by using data compiled by the Volvo Cars Packaging Operations, it was possible to further analyze the packaging network and its lead time between the terminals, production plants and suppliers, and reveal gaps within this operational loop. The study further concluded that the most critical problem in terms of time was found on supplier level, among other factors in the loop.

Keywords: Automotive Industry, Packaging, Packaging Operations, Loop-Time, Inventory Management, Network Balancing, Supplier Relationship, Volvo Cars, Closed-Loop Supply Chain.

Acknowledgement

We would first like to thank our supervisor Sharon Cullinane, for all the time and help she devoted to us during the thesis. We are grateful for her willingness to share her expertise with us through very helpful feedback and knowledge sharing. Her guidance and advice has been very supportive, helping us to broaden our perspective and examine a yet not very investigated field. We would like to thank everyone at Volvo Cars Packaging Operations who helped us. We would like to give our supervisors at Volvo Cars Packaging Operations, Eric Ristenstrand, Peter Östergaard and Christian Melander a special acknowledgement, firstly for giving us the opportunity to collaborate with you, it gave an interesting and valuable depth to the thesis. Secondly, we would like to thank you for helping us with questions and guidance throughout the thesis, specifically with limiting all the excel data we were provided with. It would not have been possible to perform this thesis without your expertise.

Thank You!

Marjan Kouchek **Alexandra Stojanoska**

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Abbreviations

Bundle - The Dispatch Unit of Empties

CMS – Container Management System

EU - The European Union

Empties - Empty Packaging

Fulls - Full Packaging

MP&L – Material Planning & Logistics

PO - Packaging Operations

RTI – Returnable Transport Item

SAAS - Software as a Service

SDP – Supplier Development Program

SSM – Soft Systems Methodology

SUV – Sport Utility Vehicle

TMS – Transport Management System

TPS – Toyota Production System

VCMS – Volvo Cars Manufacturing System

Additional Useful Information

Ghent - A city in Belgium where one of Volvo Car's production plants is located.

Gothenburg - A city in Sweden where the initial Volvo Cars production plant is located.

Skövde- A city in Sweden where one of the terminals is located.

Transport - The transport of the packaging is controlled by an organization, *Inbound Logistics* within Volvo Cars, collaborating closely with Volvo Cars Packaging Operations.

Table of Content

1. Introduction

1.1 Background

The globalization and growth of the international trade has over the past few decades been associated with the development of logistics and supply chain management. The increased volumes of international trade and its activities have resulted in many companies looking for competitive advantages by expanding and developing their supply chain and the way of managing it (Mangan, et al. 2016).

The automotive industry, used as the main example of this thesis, is often considered as the most global industry. Its products are spread around the world and are dominated by a small number of companies, often recognized globally. Vehicle production in North America, Japan and Western Europe increased most significantly in the early 90's (Humphrey & Memedovic, 2003). The automotive industry, very much like other industries consists of many different activities that are needed to keep the operations and processes working. The packaging operations of a corporation is one of the most important activities in the automotive industry and it is a further crucial and highly significant activity of any supply chain where products need to be moved from one place to another. The automotive industry is in constant need of components and parts to assemble their products, requiring packaging solutions to ensure that whatever is needed for the assembly at the production plants, is safely packaged, transported and on time.

As the automotive industry today offers a high variety of products, it is not rare that the supply chains include many suppliers who contribute with many different pieces needed at the assembly plants. Furthermore, packaging is often standardized, however, as the automotive industry constantly provides the market with new ideas and designs, some components may require specialized packaging solutions. Supply chain management in the automotive industry often comes with a lot of complexity, where activities such as choosing the right packaging solutions in a manner that will facilitate product movement, while inventory is balanced and the costs are optimized (Banker, 2010).

Packaging, viewed from an industrial perspective, is a central pillar in logistics, since it is a part of the product or component from the point of filling to consumption (Molina-Besch & Pålsson, 2014), or in the case of the automotive industry, to the point of being emptied and the

content is used. The packaging design is further important when attaining a company's environmental objectives, where focus lies on size, to optimize and limit the number of transports, but also on using standardized packaging solutions when applicable, to minimize waste and having too many unnecessary packaging options. There are many examples of standardized packaging solutions, which can be used by different companies, or even throughout the whole supply chain (Tsoulfas & Pappis, 2006).

When looking at the operational objectives, every manufacturing company has a different lead time, depending on its operations. It can vary from a couple of days to several months (Greasley, 2016). Many companies have today chosen to close their supply loop and work with reusable packaging, which enables increased efficiency of their operations. This way, packaging solutions are re-used when the output is returned to the system and becomes usable for other products to be packaged (Tsoulfas & Pappis, 2006). Returnable containers are used by automobile manufacturers when shipping body parts, and more specifically, between component suppliers and assembly plants. The importance in a returnable package system lies in the cooperation between the parties to maximize the container usage to avoid them to get lost, misplaced or forgotten (Bowersox et al, 2002).

This thesis will be based on Volvo Cars' Packaging department which will be used as an example, and its operations where the focus will lie on the total lead time of the internal packaging flow between the plants, suppliers and terminals. In order to understand large parts of this thesis it is important to understand the meaning of "loop-time". The loop-time is the total time it takes for the Volvo Cars packaging to be transported from the terminals, to suppliers and lastly to the production plants. These elements will be further explained in in chapter 2. Furthermore, the scope will include factors such as network balancing, and how the same can be improved to reach a more efficient balance than the current. If network balance is to be achieved, certain changes and improvements are required in terms of loop-time.

Additionally, there are certainly several factors affecting a company's packaging operations, everything from supplier relationships, demand forecasting and control to inventory management and right communication tools. In order to balance a packaging network of a company, and to avoid imbalance and unnecessary abnormalities in a supply chain flow it is important to acknowledge the alignment of the above-mentioned objectives, but also many other activities of significance.

1.2 Purpose

The purpose of this thesis is to examine and evaluate if the current loop-time of certain Volvo Cars Packaging solutions can be decreased and show potential measures that can be taken to achieve an optimal solution. This study seeks to examine the current packaging network, mainly in terms of suppliers, transports, and also other possible contributing factors that have an impact on the total loop-time. Furthermore, the result of this study, based on the chosen packaging types (to be further mentioned in the chapter about Volvo Cars) will potentially facilitate a discussion of future investment decisions and possible improvements to be made by Volvo Cars Packaging.

1.3 Problem Definition

Lean management is of great importance for Volvo Cars Packaging Operations, thus why it is important to improve and sustain a balanced loop-time. This includes maintaining supplier relations and having an overall balanced flow throughout the network. Therefore, the chosen research question and problem formulation for this study is:

"How is the loop-time of Volvo Cars Packaging System affected by the current network balancing and can it be improved/decreased?"

1.4 Limitations

In order to simplify the limitations and restrictions of this study, this section will present the boundaries that have been made. The main focus is on packaging logistics and more specifically in the automotive industry, hence why this thesis will not discuss retail or other industries and their packaging operations. Furthermore, Volvo Cars and their packaging operations have been used as an example for this study, hence why this thesis will not discuss the packaging operations at Volvo Group or any other automotive company as such. The packaging operations of Volvo Cars as will be presented, handle many types of packaging solutions, although, this study will not cover every one of them. Emphasis is put on three different types of packaging solutions used at Volvo Cars and only those suppliers handling them will be covered. Also, focus lies on the closed-loop supply chain at Volvo Cars, which involves terminals, suppliers and plants. Therefore, emphasis is put on B2B operations. Furthermore, this thesis will be conducted by the help of models investigating potential performance gaps within an organization, where the models may identify or expose possible

problems. Lastly, variables will not be quantified, as a qualitative approach is used, where also quantitative data will be converted to align the results to a qualitative form.

1.5 Outline

Following the introduction, presenting a background description and explanation of the topic, the problem definition, purpose and limitation of the thesis, the next sections will include a company description of Volvo Cars and its packaging operations, used as an example and perspective for the thesis. The thesis will further include a literature framework, where relevant previous research of the topic will be presented and used as a base for this study. The following section will present the theoretical framework that also will be used as a base, but most importantly to link to the empirical findings and analysis. The methodology presented next, explains the choice of research approach and how the thesis will be designed and conducted through the chosen methodology. The section of the empirical findings outline the results of the study, which will further be analyzed and discussed together with the theoretical framework and literature review mentioned. A conclusion will be outlined, as well as suggestions of potential future research. Lastly, the appendix containing additional information is found at the end of this thesis.

2. Volvo Cars - Company Description

2.1 Introduction

The Volvo name can be traced back to 1915, however it was in 1927 Volvo Group officially was formed to assemble vehicles in Gothenburg, Sweden. To clarify the reading of this research it is important to know that since 1999 the Volvo Car Corporation, today called only Volvo Cars, is no longer a part of the Volvo Group and has since 2010 been owned by Zhejiang Geely Holding of China. Volvo Cars and Volvo Group still share the same brand name and cooperate in research and development, as well as in other brand-related questions (Volvo Cars, 2017a). The focus of this section, and thesis in general, will therefore only concern Volvo Cars and its packaging operations.

Volvo Cars' mission is to be the world's most progressive and desired premium car company, making people's life less complicated. This requires a company with growth and sustainability throughout all the segments. Safety, quality and environment are three core values highly significant for Volvo Cars, and one of their main visions is that no one should be seriously injured or killed in a new Volvo car by 2020. Also, the goal by 2025 is to put 1 million electric vehicles on the roads, in order to help protecting the environment (Fall, 2017). The company is today producing a premium range of cars, including sedans, wagons, sport wagons, cross country cars, hatchbacks and SUV's. Volvo Cars is headquartered in Gothenburg, Sweden and production takes place in Sweden, Belgium, China and Malaysia, keeping the production line going since 1927 when the first Volvo rolled off (Volvo Cars, 2017b). Volvo Cars has over the years widely expanded, requiring human resources from many parts of the world, where the main share of employees is in Sweden, followed by Belgium and China (Volvo Cars, 2017b).

2.2 Volvo Cars Packaging Operations

In order for a company of Volvo Cars' size to function and operate to meet the end-customer's demand as close as possible, it is clear that there are many factors that need to be taken into account. The assembly of a car requires hard work and devotion from many actors and the size of the company also means a complex supply chain where actors such as suppliers, transporters, etc., need to align their operations as much as possible to avoid abnormalities in the supply chain flow.

One of these significant actors in the supply chain of Volvo Cars is the organization responsible for the packaging operations. As familiar, assembling a car requires many components and parts and these are sometimes not made under the same roof. Volvo Cars cooperates with many suppliers located mainly in Europe, but also in Asia and the United states. When parts and components are needed for assembly, they need to be transported to the plants in Gothenburg or Ghent and to avoid damage and other possible defects before, during and after transport, they are placed in different packaging solutions.

The Volvo Cars Packaging Operations organizational structure is demonstrated below in figure 1 and figure 2, showing the different pillars. The Packaging Operations organization today consists of 5 teams, namely the *inventory management*, the *inventory planning*, the *terminal & plant operations*, the *supplier communication & development* and lastly the *packaging operation support*. Figure 3 on the next page shows the packaging operation's main tasks and daily work.

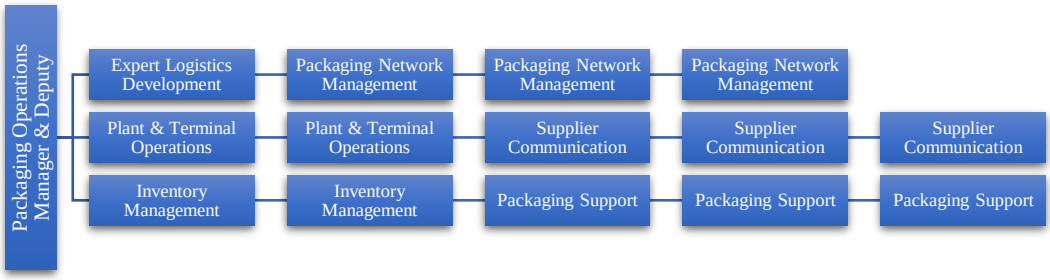

Figure 1. Organizational Structure (Volvo Cars Packaging Operations, 2017)

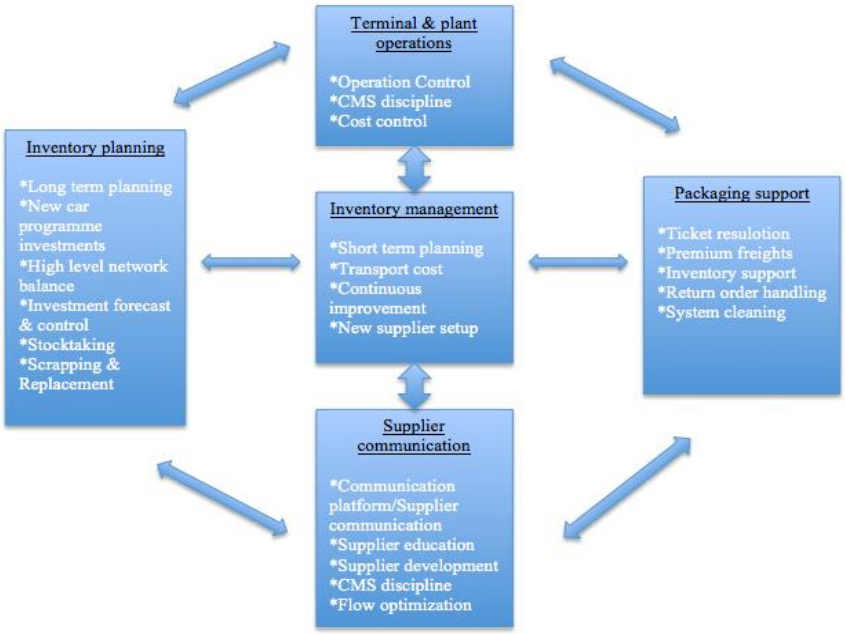

Figure 2. Developed Organization Structure. (Volvo Cars Packaging Organization, 2017)

The Volvo Cars Packaging network consists mainly of four pillars, namely the *terminal operations*, *transportation network*, *container management system*, and also the *organization* (which is the Packaging Operations Organization explained earlier in this chapter) (Ristenstrand, 2017), and is a part of the MP&L department. The journey of the operations of MP&L Packaging began in April 2014, when the Volvo Group Logistics cancelled their agreement, resulting in Volvo Cars no longer being allowed to use the same packaging solutions as Volvo Group. Therefore, Volvo Cars initiated their own packaging operations.

Their main responsibility is handling the inbound and outbound packaging between the terminals, suppliers and production plants, as well as organizing the planning, scheduling, distribution, procurement and the general supply chain management of Volvo Cars Packaging Operations (Ristenstrand, 2017). The management of the packaging flow between the terminals, suppliers and production plants will in this study be referred to as the *Packaging Loop*. To make it easier for the reader to follow the meaning of the loop and its three main pillars, a short explanation will be outlined in the following sections, 2.3.1, 2.3.2 and 2.3.3.

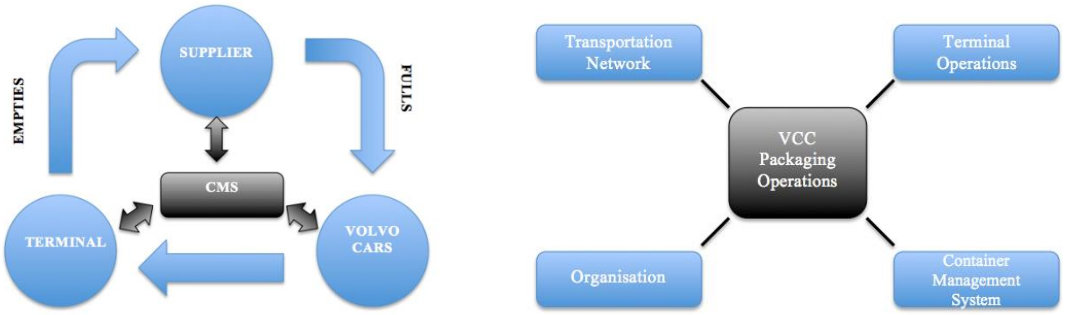

Figure 3. The Volvo Cars Packaging Network and Loop. (Volvo Cars Packaging Organization, 2017)

2.3 Volvo Cars Packaging Loop

2.3.1 Production Plants

The production plants in Gothenburg and Ghent assemble the core product of Volvo Cars, however some car models that are assembled in Gothenburg may not be assembled in Ghent, vice versa. As mentioned previously, every Volvo model's design is different even though lean management and modularization is well incorporated, which requires many different parts and components to satisfy the demands of the end customer. These parts and components are sourced from many different suppliers, some located in Sweden, others in other European countries and also on other continents such as Asia and Northern America.

2.3.2 Suppliers

The suppliers need to deliver their products to the plants and to do so, different package types are required to avoid damage and defects, but also to facilitate the handling of the components and material during transportation and once they reach the production plants. The suppliers are however only responsible to deliver their products, while the terminals where the package types are stored, are responsible to provide the suppliers with sufficient packaging. The terminals are provided with information by the Volvo Cars Packaging Operations, which controls the flow of the loop and therefore know how much of each package type needs to be sent, to which supplier, when, how and when it needs to reach the production plants.

2.3.3 Terminals

Once the filled package types are sent from supplier to the production plants, the parts and components will be used for assembly, resulting in empty packaging. When the empty packaging is returned from Volvo Cars it is distributed to the three terminals located in Ghent, Gothenburg and Skövde. The terminal services are outsourced to terminal operators, however, they all follow the same procedures and processes, and supply packaging material to approximately 1100 suppliers (located mainly in Europe).

The responsibility of the terminals begins once the empty packaging arrives (transport is organized by Volvo Cars Inbound Logistics) and enters the terminal gate and ends when it leaves. Activities performed at the terminal include operational handling and administration of physical flows, order and transport management, inventory control, measure performance, repair, scrapping, washing, waste handling, order and transport management, etc. Two main systems are used; CMS and TMS which will be mentioned later in this thesis. The terminals are open on all normal working days, and the operational hours should be aligned with the closest Volvo Cars Manufacturing unit, unless other directions are given. When closed, opening hours are agreed with Volvo Cars Packaging Operations, if there is a need of unloading/loading of packaging. Figure 4 illustrates the physical flow of packaging at a terminal.

Figure 4. The Physical Flow of Packaging at Terminal. (Volvo Cars Packaging Organization, 2017)

There are two categories, as shown in figure 5, of packaging used at Volvo Cars, where the standard packaging solutions are the most common ones, however, as cars are different, they may require special components which further requires special packaging. There are certainly many different types of packaging types used within Volvo Cars, however, as this study only considers three different types, a short presentation and explanation of the same will be given below. Also, more illustrations of the packaging types and their dimensions are found in Appendix 2 at the end of the thesis.

The first type, referred to as the L-family, which is a part of the *Wooden Pallet*-family, is a wooden packaging solution, where the base is a pallet, in this thesis referred to as the #1. The pallet can then further be built on with wooden frames, where the maximum number of frames to be used on a pallet is four. Regardless if one uses one frame or more, the packaging needs to be sealed with a plywood lid. Another member of the L-family is a fiber wood layer, to be used inside the packaging to prevent movement of the items inside (Volvo Cars, 2016b). Furthermore, the fiber wood layer, is a part of the inner packaging solutions, also called a spacer, used to protect what is being packed (Volvo Cars, 2016b).

Secondly, the Combitainer (#400) is a part of the *Large Sized Packaging Units*-family. The Combitainer does not have any parts to be added to it (Volvo Cars, 2016b).

Thirdly, the classic blue box (#780), also referred to as the plastic box, is a part of the *Blue Plastic box*-family and is one of the most common packaging solutions of Volvo Cars, as is

the wooden pallet mentioned previously. Just as the L-family contains a lid, so does the Blue Box-family (Volvo Cars, 2016a). The standard blue box used frequently at Volvo Cars and is often packed with smaller components, such as different types of screws and nuts needed for assembly.

Figure 5. Standard and Special Packaging. (Volvo Cars Packaging Organization, 2017)

2.4 INET- Systems at Volvo Cars Packaging - CMS & TMS

The packaging flow is at Volvo Cars supported by two IT-systems provided by *INET-systems*, a company that will be presented later in this section. The two systems are CMS and TMS, where CMS stands for *Container Management System*, and TMS, which stands for *Transport Management System.* These two systems interact closely with each other, where CMS is the system more frequently used at Volvo Cars Packaging as it handles the orders and the balance of packaging. TMS on the other hand handles the packaging transport requests and is handled by the inbound logistics organization of Volvo Cars (Patel, 2017).

INET, providing Volvo Cars with these systems, is a European provider of Software-as-a-Service (Saas) established in 1999 specialized in the logistics field and has since then developed globally into one of the top 5 providers of transport management systems (Inet-Logistics, 2017a). As supply chains become more complex due to internationalization, this place heavy demands on the management of shipping containers. CMS provides with transparency, and with this gained, it becomes easier for the customer to plan, control, settle and analyze container cycles. The solution enables a detailed picture of container inventories and costs, which also enables waste management. CMS provides cost optimization by reducing safety stock, lead times, and avoids additional shipments. (Inet-Logistics, 2017b). TMS offers cost optimization by increased asset utilization, prevention of unnecessary shipments. It further help reducing inventories and facilitates consolidation of shipments. The

reliability is increased by working in one consistent database which enables interaction and communication with its users (Inet-Logistics, 2017c).

2.5 Packaging, Order to Delivery – The Timeline

Suppliers collaborating with Volvo Cars Packaging and supplying the factories with material and components can place orders at any day of the week, at any time. To be able to consolidate and optimize, the Packaging Operations may need additionally up to 3 working days to complete the delivery, which further means that the supplier must take this into consideration when planning their own orders.

For instance, if the supplier location is in the Czech Republic and the terminal location is in Ghent. The administrative lead time is eight working days, which means the time between the day the order is placed in CMS and the day when the truck is loaded at the packaging terminal (in this case Ghent). The transport lead time is two working days, which is the time it takes for the packaging to be transported from Ghent to the supplier in the Czech Republic.

So, if the chosen preliminary delivery date is on a Wednesday, one shall expect the delivery to take place on the Wednesday, Thursday, Friday or the upcoming Monday (additional 3 working days past the chosen preliminary delivery date). The illustration below explains this timeline.

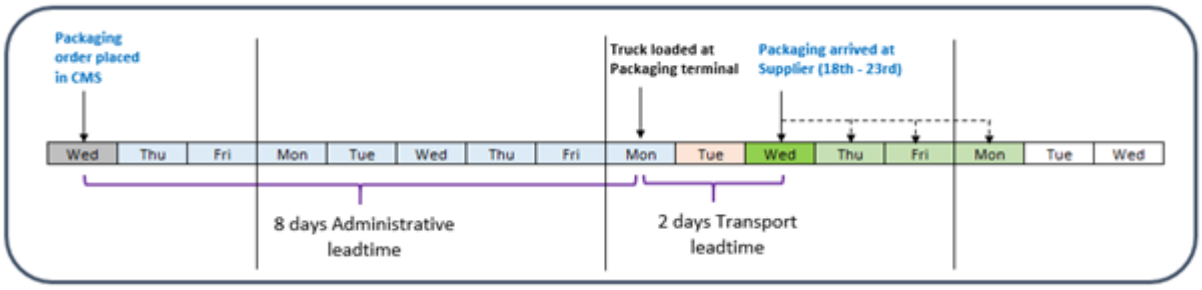

Figure 6. Order to Delivery Timeline. (Volvo Cars Packaging Organization, 2017)

2.6 Lean Management at Volvo Cars

The commitment to Lean Management at Volvo Cars is highly important where the lean mind-set is included in the way they think, manage and behave (Pragert, 2016). As also Antony (2011) suggests, lean management is not only a collection of tools, but it is also a way of thinking, with focus mainly on customer satisfaction and waste elimination. In other words, Volvo Cars prioritizes what is most valuable for the customer, and how to eliminate losses

and waste throughout processes and activities. In order to do so, they tend to use certain principles, methods and tools, where continuous improvement is essential in every aspect (Pragert, 2016).

At Volvo Cars, Lean Management is:

- You must think that a company is a team of people.
- The environment shall give the impression of a well-organized and disciplined work place.
- Teamwork and continuous improvement is of high importance to reduce waste and loss.
- Why? To reach flexible and customer controlled flows.
- Kaizen is essential

3. Theoretical Framework

Within this section, the following models, SERVQUAL and CATWOE will be presented. Thereafter, further explanation of the application of the models will be outlined

3.1 PZB's SERVQUAL-model

In 1985 Parasuraman, Zeithaml and Berry conducted a conceptual model of service quality. From now on the model will be referred to as the PZB SERVQUAL-model. The investigation made by PZB consisted of interviews with executives from four different service categories; retail banking, credit card, securities brokerage and product repair and maintenance. The insight that was obtained from the interview analysis was the discovery of gaps related to the executive's perception of service and the service associated tasks delivered to the customer. Holding a higher expectation than perception will result to low quality service, and vice versa, if the perception is higher than the expectation will result to high quality service.

PZB's research revealed the ten different service process quality dimensions that consumers go through when creating their expectations and perception about services. PZB (1985) listed the determinants and their meaning as:

- **Reliability**: consistency of performance and dependability.
- **Responsiveness**: the willingness or readiness the employees have, to provide the service.
- **Tangibles**: the physical evidence of the service.
- **Courtesy**: the contact personnel's politeness, respect, consideration and friendliness.
- **Competence**: possession of skilled personnel and knowledge that is required to perform the service.
- **Credibility**: having the customer's best interest at heart by maintaining trustworthiness, believability and honesty.
- **Security**: freedom from danger, risk or doubt.
- **Communication**: keeping customers informed in language they can understand and listening to them.
- **Access**: approachability and ease of contact.
- **Understanding/knowing the customer**: making an effort to understand customer needs.

By looking at these ten determinants it is possible to analyze the potential gaps and why they exist or occur and potential solutions (Parasuraman et al. 1985).

During 1988 PZB released another paper where they discussed the discovery of overlaps among the ten dimensions. Because of the existing overlaps, the list of determinants was reduced from ten to five. Reliability, responsiveness and tangibles remained while

competence, courtesy, credibility and security were combined and placed in a dimension called assurance. Also, access, communication and understanding the customer were combined and categorized to the dimension empathy. These five factors are described as the fundamental factors for the quality of a service. The correct and broad metric for performance measurements should include these factors (Parasuraman et al. 1988).

PZB did not only identify the gap that exists between the expected service and the perceived business, but in the later paper they also identified four other contributing gaps that were detected from the provider's side. Gap 1 exists between consumer expectation and management perceptions. Gap 2 is when the management perceptions of consumer expectation does not match the customer service standards. Gap 3 exists when the actual service performance is not aligned with the set performance standard. Lastly, Gap 4 occurs when there is an inconsistency in the firm's external communication about their service quality and the actual service performance (Parasuraman et al. 1988).

3.1.1 The Application of PZB's SERVQUAL-model

In this study, PZB's modified model from 1988 that consists of five different dimensions, Reliability, Responsiveness, Tangibles, Assurance and Empathy, will be used to analyze the possible gaps that may exist in Volvo Cars Packaging Operations. The execution of the qualitative study will further be conducted and reviewed through these different dimensions which will present some results about this study.

The reasoning behind the choice of the SERVQUAL-model is motivated by the lack of knowledge of where the problems may exist in the packaging operations. By looking at different aspects, different dimensions in this case, will hopefully produce a clear vision of gaps that may affect the packaging process that previously has been discussed. Lastly, to analyze the collected information and data that will be received, it is important to clearly state and motivate where and why the gaps exist, if they exist.

3.2 CATWOE

CATWOE is a modeling analyzing technique that is frequently used in soft system methodology. SSM is used for undertaking problematic situations. SSM is described as a process that is action-oriented where the users discover the path from uncovering a certain problematic situation to acting upon it and either solving or improving it. Learning how to cope in these kind of situations is emerged through an organized process where some

intellectual devices or tools are used. One of the most well-known models is the CATWOE model which was introduced in 1976 by David Smyth and Peter Checkland and it has since then remained the same. CATWOE represents the elements, *Customer, Actor, Transformation, Worldview, Owner* and *Environmental constraints*. CATWOE is explained as a model where intuition, real world experiences and the wish to include the present knowledge of formal systems thinking. If one were to exclude one of the six elements in the model will lead to a disadvantage in the final analysis, this further means that the CATWOE-model performs greater results when all six elements are included. In 1981, Checkland (1999) looked at the weight of the elements and found that when *Ownership* and *Actors* are included it enriches the debate. He also found that the core of meaningfulness in the model lies within the pairing of *Transformation* and *Worldview* (Checkland, 1999).

Customer, C, is the customers in the marketplace, which in other words is the people who are responsible for carrying out the production process. It is easy to confuse the term Customer to the" beneficiary" or "victim" of the systems activity. The common mistake is defining Customer too narrowly since the term does not quite represent the entire width of what it actually stands for. The Customers are the ones who benefit or suffer when the system changes. *Actors*, A, are the stakeholders that are responsible for implementing system changes. Actors carry out the Transformation process. *Transformation* or transformation process, T, represents the activity which is being modeled. The process is explained as follows: Input → Transformation process → output. Thus, there is a reoccurring issue where the input that gets transformed into the output is confused with the resources that are necessary to carry out the transformation process. Therefore, the formulation, Need for X → T → Need met, is clearer and commonly used when explaining the term T. A CATWOE analysis requires the listing of the inputs, and the change they undergo when becoming outputs. W is explained as our *worldview* and beliefs that makes the transformation process meaningful. Worldview is seen as a justification for the system transformation. It is important to be aware during the analysis that different stakeholder hold different justifications for entailing the transformation. By examining the CATWOE analysis done by each stakeholder the primary difference is related to the Worldview. Hence, it is of high importance to exclude such different worldviews and beliefs in a CATWOE analysis, and this makes W the most important step. The one/ones who have the authority to decide how to make changes, stop projects and has the final word when deciding to pursue a transformation is the Owner, O, who most commonly is (are) the investor(s) or entrepreneur(s). The Owner has the power to

stop the T. Examples of the element Environment, E, are time and resources, norms, technology regulations, and corporate objectives. In conclusion, the external constraints that may affect the system are categorized in E. There are two types of constraints, normative and determinative. While normative constraints are constituted by social constructions like ethical norms and human interpretations, determinative constraints as the law of gravity and structure of wood are given by nature. Although normative constraints are amenable to change, determinative constraints have to be worked around (Checkland, 1999).

Lastly, the CATWOE tool is used to reveal and manage problematic situation where there are many stakeholders. The tool itself does not necessarily resolve the conflict that may appear from the analysis, but it gives a clearer view of the situation at hands (Checkland, 1999).

3.2.1 The Application of the CATWOE-model

By using the situation at Volvo Cars Packaging as an example to then apply the CATWOE tool will help to facilitate the investigation. By revealing the six different elements, Customer, Actor, Transformation, Worldview, Owner and Environmental constraints, in this specific study could reveal, as well as help, to manage potential issues. It is important to highlight that all six elements need to be included when using this model in order to present the most useful results, but in this case five of the elements are applicable. As previously stated, is that one aim of this study is to create a more transparent vision of where, within realm of possibility, issues may exist. Since there is no actual Transformation element that is being applied by the company it will be difficult to map out the transformation process, therefore the analysis will not include this determinant.

Conclusively, the vision of the information that may occur after applying this model is for it to include intuition, real world experience and present knowledge systems thinking, as the model is set to. The goal is to acknowledge the elements and their weight in this specific investigation.

4. Literature Review

This section will outline the literature used as a base for this study and is divided and structured around nine headings, discussing packaging in general, but also packaging operations in the automotive industry. Furthermore, to give the reader an understanding of the topic from different perspectives, this section will also highlight literature regarding other important pillars such as inventory management, investment decisions, supplier network and relationships, as well as the meaning of supply chain communication and lean management. The literature review for this study will then be tested on the empirical data and included in the analysis.

Modest contribution to the limited literature regarding packaging operations is unfortunately a fact, with the available literature being very dispersed and categorized by different names such as reverse, reusable and industrial packaging, closed-loop supply chains, industrial packaging, etc. A possible explanation to this as argued by Guide et al. (2013), is that researchers remain conservative and reluctant to change as focus mainly lies on the classic supply chain.

4.1 Supply Chain Management - Linear to Closed-Loop Operations

The traditional supply chain management has in the last decade faced some new trends mentioned by (Battini, et al. 2017) among others, where names such as closed loop supply chains and reverse logistics have attracted more attention, and this is mainly to reduce the environmental impact on the whole supply management by working with waste management and also due to environmental regulations such as the *Packaging and Packaging Waste Directive* by the EU; 94/62/EC (Silva, 2013; Hellström & Johansson, 2010; Zhou et al. 2017; European Commission, 2017).

Replacing the classic linear supply chain with a closed loop results in complexity arising in terms of managing inventories, return flows, transportations, customer service and the general orientation and coordination of the resources (Battini et al, 2017). Information flows controlling the return processes become more uncertain, especially as there is now a need to coordinate both forward and return flows of information and material (Battini et al. 2017). The main task and crucial challenge of closed-loop supply chains is therefore to synchronize the system handling the flow of products, where facilities, distribution systems, etc., are aligned with customer demand (Sundar et al, 2013). However, according to Guide et al. (2003), the future challenges of closed-loop supply chains include increased global competition, shortened life cycles, and an expanded environmental legislation. Also, an

expected decrease in margins with overcapacity in the global markets may result in increased handling costs. Guide et al. (2003) further stress that problems occurring in closed-loop supply chains may include lack of integration of the different activities. Also, the problems are not often tactical or operational, but rather strategic and lacking structure.

The packaging trend moving from disposable to recyclable packaging solutions (McKerrow, 1996), often referred to as closed-loop supply chains is frequently explained as being a result of environmental regulations and the business opportunities that are related to the remaining value of products that have reached the end of their cycle (Guide et al., 2003). A closed-loop supply chain is classified into several activities that include returns which affect the design and management of the supply chain (Hellström & Johansson, 2009), where the RTI's are used for internal transport of materials, components, semi-finished and finished products, expected to be returned for further usage (Hellström & Johansson, 2009). The RTI's include, among others, boxes, lids, containers and pallets (ISO, 2005).

A significant factor in this trend, according to Twede & Clarke (2004) is that the traditional cost allocation balance is somewhat disturbed since it requires a large initial investment in packaging. This results in additional transport costs, an infrastructure for empty container sorting, such as a terminal, and also tracking systems and quality control. Twede & Clarke (2004) further argue that the supply chain will gain benefits by using reusable packaging solutions, since the cost of purchasing and discarding packages for every shipment is eliminated, however, when it comes to the users, some find that reusable containers are profitable, while others find that relationships, costs and/or operational issues are unaffordable.

Most of the goods that pass through a terminal or a distribution center are packed, and this mainly to contain, protect or preserve the product, as well as to facilitate handling, storage and the providing of information. Regardless, as the end customer will require the goods to arrive securely, the terminal or distribution centers need to be designed in a certain way so that the order quantities to be dispatched can be so in a cost and time effective way (Rushton et al, 2014).

4.2 Packaging

The literature discusses different perspectives in terms of packaging operations, where the more logistical perspective, rather than the consumer perspective is discussed by both Bowersox et al (2002) and Prendergast & Pitt (1996). To clarify, the consumer perspective is when packaging is designed in a way to satisfy the end customer in a B2C environments and is more marketing related, while the logistical perspective is rather more concentrated around B2B, where the design is considered in a practical way.

As mentioned, packaging operations and the solutions themselves are important pillars of logistics as they are linked to the product from the point of filling to the point of the product being unpacked or consumed. The packaging operations affect every logistics activity, including the overall economic and environmental efficiency of a company and its supply chain (Molina-Besch & Pålsson, 2014; Bowersox et al (2002). Rushton et al. (2014) also argue that packaging is an important factor of the total logistics functionality, as well as the design and use of it and these factors have implications not only on the production and quality control, but also on the general logistics costs and performance.

Bowersox et al (2002), further explain how the logistical activities are affected by packaging, where inventory control relies on the accuracy of the system chosen for the packaging management and how order selection speed, accuracy and efficiency are influenced by how the packaging is identified, configured and handled. The handling cost further depends on technique while transportation and storage costs depend on the size and density of the packaging. Lastly, customer service will depend on the achievement of quality control in terms of distribution, convenience for the customer and how environmental regulations are incorporated (Bowersox et al, 2002). Purchasing of materials, packaging operations and the constant need of material being distributed, account for the most obvious costs of packaging and further explain the significance and impact packaging logistics has on both cost and productivity of a company (Bowersox et al, 2002).

When a company wants to replace disposable packaging solutions with returnable packaging solutions, there is a need of considering the advantages and disadvantages with doing so. The literature often mentions the benefits to be gained by choosing returnable packaging over disposable to be improved product protection, decreased costs, as well as legislative and

environmental advantages (Silva, 2013), however, when comparing the pros to the cons, the benefits tend to exceed the disadvantages, linking us to the trend highlighted by McKerrow (1996) and Twede & Clarke (2004).

McKerrow (1996) emphasizes the economic benefits of reusable packaging, where the most obvious are the cost savings in purchase and reduction of waste disposal. Also, the use of standardized reusable packaging brings cost savings in terms of reduced product damage, improved vehicle utilization, even if the loads are mixed.

Packaging further facilitates the standardization of storage facilities, and the handling direct into point of use in manufacturing (McKerrow, 1996). Rushton, et al (2014) further highlights the importance of design of terminals and distribution centers, in order for products to be contained and preserved securely, as well as to facilitate the handling, storage and information sharing regarding packaging. Consequences stressed by Kroon & Vrijens (1995) regarding the use of returnable containers include additional transportations back, as well as the system requires cleaning, maintenance storage and administration of the containers, connecting to the factors of Rushton, et al (2014) system design.

RTI is an additional abbreviation describing the new trend of replacing the single-use packaging. The items are used for shipping products along different stages of the supply chain and then sent back to the sender by the recipient to be cleaned, repaired or replaced (Battini et al. 2017). The benefits have been embraced by various industries, putting the single-use packaging into shade as they are adopted to reduce packaging waste and overall logistics expenses. An example of meeting environmental regulations is the Waste directive 94/62/EC of the European Union (Hellström & Johansson, 2010; Silva, 2013). Lutzebauer (1993) distinguishes three systems, where systems with return logistics include the ownership of containers by a central agency, which further is responsible for the containers to return after being emptied by the recipient. McKerrow (1996) further strengthens the argument of systems of reusable packaging being optimized when the quality of packaging purchase is the responsibility of a designated entity, ensuring that needs are met, while the costs are fairly shared between the users (McKerrow, 1996), including the factors mentioned by Kroon & Vrijens (1995).

4.2.1 Packaging in the Automotive Industry

Packaging operations in the automotive industry many times means returnable packaging as there often is a complex supply chain involved. In automotive logistics, returnable packaging consists mainly of plastic or steel (Zhang, 2015; Bowersox et al., 2002), due to their longer lifetime, compared to the wooden solution, which is more exposed to the risk of damage (Zhang, 2015).

The importance of returnable packaging has become crucial in the automotive industry as it is constantly facing cost reduction pressure to handle competition and lower profit margin and the interplant shipments have further given incentives for returnable packaging for shipping body parts for continuous assembling. The use of returnable packaging is therefore mainly occurring between component suppliers and assembly plants where the responsibility and great cooperation lies in maximizing container usage (Bowersox et al, 2002), to avoid containers being lost, misplaced or forgotten in the supply chain.

The literature further emphasizes two different modes used in packaging management in the automotive parts logistics, namely the dedicated mode and shared mode, where the shared mode will be the most accurate for this study. The dedicated mode involves suppliers who use their own packaging, compared to the shared mode where the packaging is shared among the suppliers (Zhang, 2015). The shared mode helps companies to reduce their safety stock as it is centrally managed, however, required information systems and collaboration between the actors can result in further management costs.

Swedish examples of the shared mode usage are found at Scania and Volvo, who both operate with the shared mode controlled by information systems, while the Shanghai General Motor in China collaborates with their *Container Management Center*, a branch which designs, procures and manages the containers (Zhang, 2015). The US automotive industry being a significant user of reusable packaging has recognized the cost benefits since the 1990s, mainly by incorporating second and third tier suppliers into their supply chains (Twede & Clarke, 2004).

4.2.2 Packaging & Investment Decisions

Bowersox et al (2002) stress the importance of involving and considering several shipment cycles and return transportation costs, versus purchase and disposal costs of containers, where also benefits of improved handling and reduced damage should be considered in the calculations. Moreover, future costs of sorting, tracking and cleaning the reusable containers need to be calculated when conducting a financial analysis. It should further be based on net present values. Kumar & Putnam (2008) emphasize the cost profit aspects of reverse logistics and that the total expected profit can be achieved using their model consisting of fixed suppliers, facilities, (re)-distributors, etc. Zhou et al (2017) further investigates manufacturing and remanufacturing closed-loop networks in different industries, among them a manufacturer and supplier based on a control system investigating inventory variance.

4.3 Unit loads

In terms of unit loads, this idea was developed due to the high costs that involve storage, distribution and movement of packaging. The inefficiency demanded a solution, which came to result in, among other solutions of course, the unit load concept, where grouping packaging together enables space management, and can also be easily moved by using mechanical equipment.

The classic wooden pallet has certainly revolutionized the physical distribution of packaging and thereby also the general logistics operation. The choice of the most appropriate type and size of unit loading will further minimize the frequency of total material moment, allowing cost management, and also as the amount of transports decreases, this will decrease the lead times, however, most importantly it will improve the product protection and security (Rushton et al, 2014). As the majority of systems are unplanned and evolve and develop over time with the company, these changes can mean both a steady growth, with large steps, as well as a decline with short steps, hence why logistics networks may fall out of balance – it takes a lot of work and effort, hence why packaging and unit loads are two significant factors when planning a logistics network (Rushton et al, 2014).

4.4 Inventory Management

Having a good inventory management can give several benefits when assessing a company's profitability. Wild (2002) describes in his literature how inventory management techniques

are used in practice and how they actually can deliver good results for companies that have used them.

It is safe to say that everyone practices inventory control, both at home and at work. For instance, everyone tends to keep clothes, shoes papers, food, to mention a few. Also, people, just like companies, make emergency purchases. Another resemblance between people and companies is that we tend to throw away goods that have aged and changed in character which we feel are not as usable than before. Inventory control is an activity exercised frequently, both privately and in organizations, although some tend to execute it better than others (Wild, 2002).

Great inventory techniques can help to reduce the inventory value, avoid unnecessary endeavors, and improve customer service. The basis of inventory management, regarding companies that supply other companies with goods, is to have the products ready, at a good price and deliver within the prearranged time. For future activities, it is also important to keep a consistency of supply for the customers. Inventory control manages the availability of demanded items for the customers in the marketplace and facilitates the coordination of purchasing functions, manufacturing functions and distribution functions. Having inventory will support companies to assess the manufacturing and logistics activities when the purchasing and manufacturing departments are unable to meet the requested demand (Wild, 2002).

Inventory control is described as a dynamic activity; therefore, it is important for the inventory manager to keep the balance right for a successful stock. These actions require good communication skills as well as professional stock techniques. Higher control will lead to lower costs, which in hand will lead to a lower stock level, and lastly, a better customer service providence (Wild, 2002).

Optimizing s customer service together with inventory- and operating costs, as the main objectives of inventory management, is the sole purpose of the inventory control function in business activities according to Wild (2002). Although, one should have in mind to not optimize one at the expense of the others, since it would generate low profitability results. Generating low profit will in the short run lead to the company going out of business. Also, low customer service will in the long run result in the customers leaving the company and the company will then go out of business. By balancing both the financial and the marketing functions will generate the best results for the inventory manager. Customer service is

considered to be the availability of ex stock, meaning the goods that are available immediately from the supplier stockholding, those goods have very little or practically no lead time at all. To reach the optimal inventory costs target on the other hand, requires the lowest amount of cash tied up in stock. More attention has been brought to operating costs that evolves from store operations, stock control and purchasing operations since the aim is to avoid those costs when practicing inventory management. Balancing the three objectives mentioned above will result in better profits for the company. By balancing, it means to simultaneously, and not separately, meet the objectives (Wild, 2002).

Wild (2002) further argues that experience has proven that businesses that have the highest stock levels are the ones who have the worst availability, while it in fact should be the other way around. High stock levels occur by inadequate forecasting, inaccurate monitoring or poor control.

Withholding a safety stock, which is a buffer between supply and demand, depends on different factors, either because of demand variability, supply reliability or transport dependability. Although Wild (2002), mentions that the optimal amount of stockholding corresponds to the amount of demand. The easiest explanation for the reason of inquiring a safety stock is that it primarily covers different unexpected variations in demand, but also supply and transport failures or inaccurate information distribution. Safety stock facilitates the separation between customer service and manufacturing, thus enabling efficiency and independency between the two.

Buying safety stocks is a way of assuming that at some point in the future there will be a demand for the goods. This is a type of forecast, but to acquire an adequate amount of stockholding requires a high quality of forecasting. The definition of good forecasting could be translated as having a low stock, and vice versa; bad forecasting is seen through a high stockholding. The forecast should be based on accurate and appropriate data which can often result in difficulties since forecast usually is based on data of predicted sales for the future instead of historical data (Wild, 2002).

4.5 Supplier Network & Supplier Relationship

Molina-Besch & Pålsson (2014) argues that the involvement of packaging suppliers is very common in a supply chain, where the main reason for involvement is the technical support

they need. Lumsden (2012) explains that the general development of a company's supplier portfolio today shows a decline in the number of suppliers. The importance of spreading the risk and not being dependent on a small number of suppliers has over the years further declined, and the trend has rather been replaced by a smaller supplier portfolio where the importance lies more on improved, closer relationships, transparency and less administrative work. When a company chooses to work with a smaller number of suppliers, this enables knowledge sharing, such as technical, social, economic and legal skills and by doing this, it can help a company reach goals which otherwise would be harder to achieve. The knowledge sharing can thus improve the company's efficiency Lumsden (2012)

4.6 Supply Chain Communication

Today's complex supply chains and business environments often require putting an effort on long-term relationship with suppliers. There is however an existing problem where many firms overlook the importance of building effective and stable relationships with their suppliers in order to ensure performance levels and instead choose to cut suppliers loose before taking the time to build a proper relationship.

Prahinski (2007) argues how cooperative relationships with critical suppliers has increased and the importance of evaluating supplier portfolios to ensure that performance and objective goals are met. Supplier evaluations are therefore a tool but also an attempt used as a SDP to meet both current and future needs and use it as a basis for improvement of supplier performance. Prahinski's (2007) study, based on American automotive suppliers, shows how evaluating the suppliers does not directly affect the supplier performance and the explaining factor of this is the level of commitment to the buying firm. The higher the effort from the buying firm in terms of cooperation and commitment, the better influence on the buyer-supplier relationship. Complex supply chains have increased the demand of computer-based communication and the main communication approaches for communication in manufacturing industries, highlighted by Cutting-Decelle, et al (2007).

Supply chain management faces challenges in terms of communication as it is often separated from the supply chain activities. Jacobs et al (2016) study revealed that internal communication does indeed have a significant and positive effect on employee satisfaction, which together have a significant influence on internal integration. Moreover, the study showed indications on how an integrated internal communication has a positive effect on external integration. Jacobs et al (2016) further stress the importance of communicating with employees as this will facilitate improved satisfaction and integration both internally and

externally in the supply chain, where effective communication together with satisfied employees are important pillars for improved performance of a firm in terms of coordination of material, information and capital. Droge et al (2004) study is focused on the automotive supply industry and also they agree that both internal and external integration in terms of interaction is significant to firm performance, but also stress the level of integration being significant for time to market.

Zsidisin et al (2015) study examines whether an organization's internal communication climate is related to an improved internal integration of supply management within an organization and if this will give incentives for improved supplier integration and supplier performance. The main findings confirmed other mentioned researcher's results. This study, based on supply market scanning, shows a positive connection between internal communication and internal integration of supply management, thus why also internal integration is positively connected to supplier integration, which further will affect the relationship with supplier performance. In other words, this explains the importance of internal integration of an organization and how this may have positive and direct impact on supplier performance (Zsidisin, et al 2015).

4.7 Lean Management

The Lean thinking is today familiar to many as a concept which developed from the TPS. Lean management involves distinguishing value-adding activities from non-value adding activities, where the main goal is to eliminate waste as much as possible. The lean management concept focuses on efficiency, where the main goal is to produce products and services at the lowest cost and at the fastest pace possible (Antony, 2011).

Antony (2011) further argues that the commitment to lean thinking should start at a top management level, and then continue the flow according to a top-down strategy, where various levels of the organization are included to improve the flow and efficiency of the processes. The lean thinking concept enables efficiency through different tools and techniques to reduce lead times, inventories, setup times, equipment downtime, scrap, rework and other non-value adding activities in a factory.

4.8 Summary Literature Review

The focus of this charter has been to give the reader an overview of some essential elements affecting the packaging operations of a company. As the trend towards closed-loop supply

chains is increasing, so has the importance of integrating the different components and factors mentioned above, such as supplier network and supplier relationships. The packaging operations of a company requires a high degree of balancing in order to avoid negative chain reactions in the packaging flow. To prevent such situations it is crucial to have a reliable inventory management, where the functions are transparent and the communication is trustworthy throughout the chain. This also gives incentives for a well-structured lean management of a company, especially in the automotive industry, due to the importance of eliminating waste and satisfying the end-customers. Also, having a well-managed supply chain will further facilitate investment decisions, as having a higher level of control increases the transparency and will lead to a greater overview of where investments could be applied. Conclusively, working with unit loads has enabled optimal utilization concerning the transportation of packaging from on place to another, which is a necessary precaution when wanting to accomplish an aligned flow.

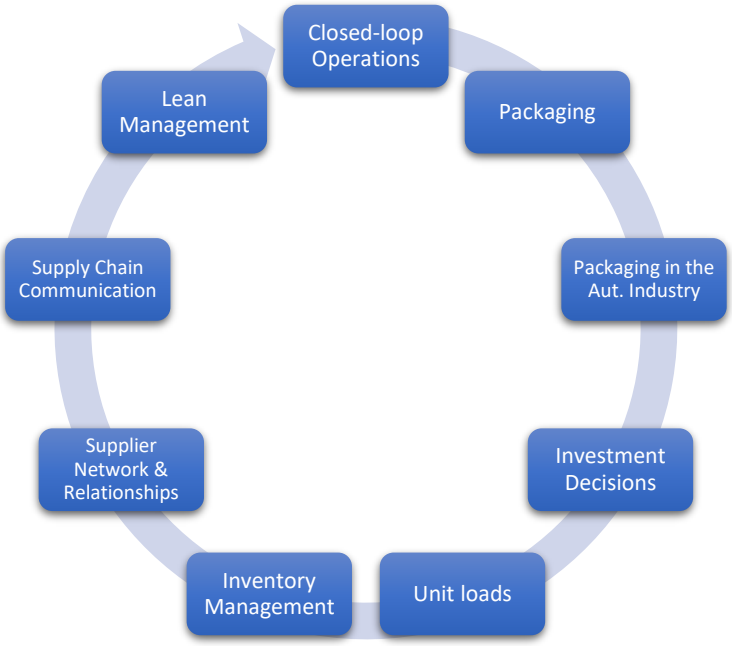

Figure 7. Overview, literature review. (Author's own depiction, 2017)

5. Methodology

In this chapter the chosen research paradigm, research approach and investigation methods are described and a discussion of the strengths and weaknesses in context to the alternatives is applied as well. Further, a description of the analyzed variables, measurement levels, measurement units and codes demonstrated will be presented. Lastly, existing ethical issues, along with chosen limitations and reliability, validity and generalizability constraints are discussed.

When designing the chosen research, there were some acknowledgements that were considered. A good research design is characterized by it having an existing fundamental framework or structure, and also that it allows the researchers, in this case, to be able to address the research question, thus achieving the goals and objectives of the investigation (Collis & Hussey, 2013). The research problems have already been presented and it exists within the scope of logistics.

5.1 Research Paradigm

There are two main paradigms, positivism and interpretivism. Paradigms are described as philosophical frameworks that helps guide scientific researches. Interpretivism is philosophically referred to as idealism. Interpretivism advocates that social reality is highly subjective and not objective due to the fact that it is shaped and formed by personal perceptions. Interpretivism underpins the belief that separating what exists in the social world with what is in the researchers' minds is impossible. Therefore, conducting investigations affect social reality, and the aim is to perform inductive research to view an interpretive comprehension of social phenomenons. The main difference between interpretivism and positivism, according to Collis and Hussey (2013), is the fact that, positivism assumes that social phenomenon's can be measured, thus associating positivism with quantitative method approach with statistical data analysis, while interpretivism adopts methods that describes and translates natural phenomenon's in the social world. Conclusively, interpretative research refers to any research where the findings are not derived through statistically compiled quantitative data.

For this study, an interpretivism paradigm is the most suitable one, hence, the approaches are qualitative, subjective, humanistic and phenomenological. According to Collis and Hussey (2013), interpretivism tends to produce "rich", subjective and qualitative data, also it produces results that gravitate towards low reliability and high validity, which will be further discussed in the next section. Within the chosen paradigm, the use of small samples is more common,

which will be applicated in this research. An interpretive approach also allows the findings in the research to be generalized to other similar settings and investigations.

5.2 Qualitative Approach

The researchers chose an interpretive study; therefore, a formal style will be adopted, together with a personal voice, accepted qualitative terms and limited priori definitions (Collis & Hussey, 2013). The choice of an interpretive study is motivated through the reasons that it will convey a research for patterns, theories and categories to understand during the process.

The chosen method of this study is in a qualitative form. The reason for this method was motivated through the data that was accessible for the investigation. To be able to perform this research it was of great importance that the existing data is used and analyzed. The data and information has been compiled through Volvo Cars Packaging Operation's network system and by the chosen theories and models that are found in the theoretical framework chapter, as well as previously conducted research which is presented in the literature review chapter. The data collection at Volvo was given to the researchers through authorized personal usernames and passwords to Volvo Packaging Operation's network system.

Although a qualitative approach has been chosen, quantitative data has been complied and analyzed. There was an extensive amount of excel-files provided to the researchers by their supervisors at Volvo Cars Packaging Operations, which became very useful and important when conducting the research. Even though a qualitative approach has been chosen due to it being the most suitable one, one must not neglect the acquired time and resources used when collecting the valuable quantitative data for the analysis.

5.2.1 Motivating Factors for a Qualitative Study

The reasoning behind the choice of a qualitative study rather than a quantitative is partly due to time limitation. In a perfect world with an unlimited amount of time the choice would most likely have been a combination of the two since it would with the highest probability have produced results with higher validity, reliability and generalizability.

Also, since the models that have been chosen for this study are better suited for a qualitative study also motivates the choice. The data that will be received and compiled are not in a quantitative form, therefore, it would be more complicated to perform a quantitative study. Although, it is still intended to look at quantitative data when conducting the investigation,

the numbers will further be transformed into a qualitative form and later applied to the research.

Another reason behind the choice of method is the fact that the aspects that will be studied are difficult to quantify, and in some cases, cannot be quantified at all. Compiling relevant results and conducting an informative analysis demands a well applied method that flows hand in hand with both the theoretical framework as well as the literature review that is presented below.

5.3 Action Research

The investigation was set to be performed as a form of action research, where the researchers will collect a few actors from Volvo Packaging and create a group discussion between the employees. The researchers ask questions related to their research and observe and record the answers and discussion that may occur between them. According to Collis and Hussey (2013), an action research goal is to enter a certain situation and attempting to bring about change and then monitoring the results. They also mention an example where the methodology action research is well applied, for instance in a study where concentration is set on improving communication between the management and the employees in a specifically chosen company. There is a philosophical assumption regarding action research which says that expresses how the social world is frequently changing and the conducted research as well as the researchers are a part of this change. This form of methodology is explained as a cycle of planning, acting, observing and reflecting (Collis & Hussey, 2013). Primarily, the planning part of the cycle is when the researchers identify the objective they intend to reach and the path to reach it. In this research, the objective is to find possible gaps that may affect Volvo Cars Packaging's loop and loop-time.

It is important that the researchers and the client organization agreed about the aim of the study and that they had a mutual control regarding the investigation as well as the analysis of the results. One of the main characteristics of this type of research is that the researchers are obligated to examine the whole complex issue, but also to make it transparent enough so that everybody comprehends it.

5.4 Group Discussion

This research was performed together with a group discussion. The sample size was small and consisted of four key persons from the Volvo Packaging department. The persons all have

different work tasks. We chose one person who works with supplier communication and development, one that works with packaging operation support, one that works with the terminal and plant operations and lastly one that works with inventory planning. Since the teams all work closely together and have a very transparent workplace it facilitated when assembling the group discussion. The chosen sample were all very cooperative which resulted in a very smooth execution of the discussion.

Before the discussion, which was held in a separate room close to everyone's working space, all four respondents were informed that the discussion would be recorded with the researchers' smartphones and that the recorded material was only intended for their own use. All four participants were promised anonymity to provide them with security to increase their comfort.

5.4.1 Purpose of the Group Discussion

The purpose and motivational factors of this group discussion, was mainly to get an insight of the internal communication and to listen to the thoughts and opinions the employees of the different teams at Volvo Cars Packaging Operations have, regarding the unbalanced loop-time they are facing. It was also of interest to see how the teams are affected by this problem and how they, internally, believe that the problem can be affected and improved. As thesis authors, our perspective of the problem is limited, as we are not involved in the daily work as much as the employees, and therefore the group discussion is meant to be used to give us a clearer insight. The group discussion is based on approximately 10 questions, further based the SERVQUAL-model by PZB mentioned in the theoretical framework. The group discussion is further based and discussed on the model's 5 dimensions, analyzing possible internal, but also external gaps in an organization. Also, open questions were asked to get a clear picture of what the employees themselves think of the problem and its underlying factors. The questions asked are added in appendix 3.

5.4.2 Methodology Limitations

An attempt to contact the suppliers was made in this study to further strengthen the investigation by also gathering information about the supplier perspective. Unfortunately, not all suppliers replied, and the information received from some was not complete. Therefore, the decision of excluding the supplier questionnaire for this study was concluded. The researchers contacted four suppliers, which are more closely described in chapter 6, *IAC Group, Skara*, *Supplier Partner, Magna Mirrors GmbH & Co. KG* and *Fremach Trnava s.r.o*.

Altough, there were information that could have been analyzed and conducted in this thesis, the researchers found that it was not enough to draw major conclusions.

5.5 Reliability, Validity and Generalizability

5.5.1 Reliability

Reliability refers to the accuracy and precision of the measured data, and whether or not the results would remain the same if the study was repeated. If the research was conducted in several different occasions with the same exact data collection and the results would remain the same as they were the first time, the research would hold a high reliability. In a positivist study, it is of high importance that replication is applicable. It has been acknowledged that executing studies where there is high reliability and low validity is more common than conducting studies with low reliability and high validity (Collis & Hussey, 2013).

The reliability of this research has been attempted to be strengthened through several precautions and the questions asked have been documented and inserted as an appendix and the group discussion was recorded. The authors were aware of the fact that the semi-structured discussion would tend to decrease the reliability, therefore they chose to include the follow-up questions that generated conclusions of high weight in the appendix as well. This was executed due to the reason of increasing the reliability so that the same repeated study would result in uniform conclusions.

5.5.2 Validity and Generalizability

Validity is explained by the extent to which a test measures what the researcher wants it to measure, and the results received reflects the studies phenomena. Validity can be undermined through faulty procedures, poor samples or inaccurate or misleading measurements. Validity can be assessed by face validity or construct validity. Face validity involves the assurance that the researcher tests or measures actual measures and represents what they intend to. Construct validity relates to the problem of non-observable phenomenon’s, such as motivation, anxiety, ambition and satisfaction (Collis & Hussey, 2013).

The questions that were asked during the group discussion, was conducted beforehand based on the information that was sought for. To be able to supplement and ensure that the gathered data made a truthful representation of the reality, some company documents were collected and used to strengthen the study. As previously mentioned, the respondents in the group discussion were promised anonymity to increase their comfortability and decrease the feeling

of pressure and stress. Another factor that has enhanced the validity in this research is the triangulation of data, using several sources such as internal documents. The researchers' supervisors at Volvo Packaging has been present and has facilitated the path towards the construction of the questions. Furthermore, the opportunity to read the thesis was given to the supervisor to validate the study once more.

Generalizability refers to the research findings application on other cases, often based on a sample, or other settings. From an interpretative view, generalization may be possible if the analysis of the research has been able to capture characteristics and interactions of the studied phenomena. Although, generalizability may be difficult in cases where the investigated activities and behaviors have not been well comprehended (Collis & Hussey, 2013). The generalizability of this study is difficult to measure due to the fact that the company in question operates in a certain environment and with their own processes and systems.

6. Empirical Findings

This section will demonstrate the empirical findings. Firstly, an overview of the supplier portfolio of Volvo Cars Packaging will be presented, where the focus lies on significant supplier countries and packaging types. Secondly, a comparison of the current and forecasted data between the countries in the supplier portfolio that demand the highest amount of packaging, are described more in detail. Lastly, an overview of the outcome from the group discussion will further be elaborated.

6.1 Supplier Network

The supplier portfolio at Volvo Cars Packaging Operations consists of suppliers from many countries, and the lion's share of them located in Europe. There is however a cooperation with countries outside Europe, where Turkey is the closest non-European country, while the United States and Asian countries such as China, India, Japan, Taiwan, Korea etc., also have an important role in Volvo Cars operations, providing the production plants with needed parts (Volvo Cars Packaging Operations, 2017)

The main role of the supplier is to receive the empty packages from the terminals in Ghent or Gothenburg, and fill them with parts and components needed at the assembly plants in Ghent and Gothenburg. Once the packages have been emptied at the plants, they are then returned to the terminals to be washed and stocked until needed, and possibly repaired if any damage has been detected (Volvo Cars Packaging Operations, 2017).

Firstly, important to have in mind is that this study only considers three package types and that not every supplier cooperating with Volvo Cars Packaging is considered. By using the data provided by the Volvo Cars Packaging Operations, it was possible to map the suppliers operating with the chosen packaging solutions for this study. Therefore, this section will outline the origin of the suppliers, connected to each package type. Also, this section will outline how many suppliers there are per country to see the level of significance in terms of the three package types (Volvo Cars Packaging Operations, 2017)

Table 1 on the next page shows that the total number of suppliers operating with #1, #400 and #780 is 402. The table also demonstrates, marked with green, the countries with the highest number of suppliers operating together with Volvo Cars Packaging, where Germany stands for the largest number with 82 suppliers, followed by Sweden with 71, Czech Republic with 32, Poland, 29 and lastly China with 25 suppliers. The table also shows how many, more exactly 12, countries only operate through one supplier. The majority, more exactly 8, of

these suppliers are located outside the European continent and many times in Asia. Only one supplier is located in the United States of America (Volvo Cars Packaging Operations, 2017).

Country	**Total No. of Suppliers**	**Country**	**Total No. of Suppliers**
Austria	4	Korea (S)	1
Belgium	20	Lithuania	1
Bulgaria	1	Netherlands	6
Switzerland	2	Norway	2
China	25	**Poland**	29
Czech Republic	32	Portugal	3
Germany	82	Romania	8
Denmark	2	Serbia	3
Estonia	1	**Sweden**	71
Spain	21	Singapore	1
France	20	Slovenia	2
Great Britain	6	Slovakia	13
Hong Kong	1	Thailand	1
Hungary	18	Turkey	4
Ireland	1	Taiwan	1
India	1	United States	1
Italy	13	Vietnam	1
Japan			**∑ Suppliers = 402**

Table 1. Suppliers Operating with Chosen Packaging Types. Divided by Country. (Volvo Cars Packaging Organization, 2017)

Table 2 demonstrates the countries operating with the package types #1, #400 and #780. To clarify, the countries and suppliers in the table certainly operate with other package types as well, however, these numbers are only considering #1, #400 and #780. This table distinguishes the three package types and the number of suppliers handling the same. So, for instance, the table shows how Germany has a total number of 82 suppliers handling #1, #400 and #780, and how 76 of 82 suppliers handle #1, 4 of 82 handle #400 and 46 of 82 handle #780. The cells marked with green demonstrates the five countries who operate with the largest number of suppliers depending on packaging type. This is further clarified in the next table (Volvo Cars Packaging Operations, 2017).

Country	Total No. Of Suppliers	#1	#400	#780	Country	Total No. Of Suppliers	#1	#400	#780
Austria	4	4	0	1	Netherlands	6	6	0	0
Belgium	20	15	6	15	Norway	2	2	0	0
Bulgaria	1	1	0	1	**Poland**	29	26	3	18
China	25	22	0	22	Portugal	3	2	0	2
Czech Republic	32	26	3	12	Romania	8	7	0	5
Denmark	2	1	0	1	Serbia	3	1	0	1
Estonia	1	1	0	1	Singapore	1	1	1	1
France	20	16	0	9	Slovenia	2	2	0	1
Germany	82	76	4	46	Slovakia	13	12	1	4
Great Britain	6	5	0	2	Spain	21	21	0	5
Hong Kong	1	1	0	1	**Sweden**	71	64	13	44
Hungary	18	15	0	9	Switzerland	2	2	0	2
Ireland	1	1	0	0	Thailand	1	1	0	0
India	1	1	0	1	Turkey	4	4	0	2
Italy	13	13	0	5	Taiwan	1	1	0	0
Japan	4	4	0	3	United States	1	1	0	0
Korea (S)	1	1	0	1	Vietnam	1	1	0	0
Lithuania	1	1	0	0					
∑	**402**								

Table 2. Supplier Operation Divided by Country and Type. (Volvo Cars Packaging Organization, 2017)

As mentioned, this table demonstrates the top five countries operating with the three packaging types chosen for this study. The table also shows how Germany and Sweden are together the two most important countries when looking at the supplier portfolio operating with the #1 and the #780, however not for the #400, where Belgium operates with 6 suppliers compared to Germany's 4 suppliers. The table also tells us how the #1 and the #780 are more widely operated with compared to the #400 and the explanation to this is that the standard packaging types are more demanded rather than the *Combitainer* (#400). Also, the proximity of the suppliers to Sweden and Belgium (as Belgium also has a production plant), is an advantage. Also, the countries are all members of the European Union, which facilitates the bureaucratic and administrative factors. China is certainly an exclusion in this case (Volvo Cars Packaging Operations, 2017).

	#1	#400	#780
1	Germany (76)	Sweden (13)	Germany (46)
2	Sweden (64)	Belgium (6)	Sweden (44)
3	Czech Republic (26)	Germany (4)	China (22)
4	Poland (26)	Czech Republic (3)	Poland (18)
5	China (22)	Poland (3)	Belgium (15)

Table 3. Top 5 Countries Operating with Packaging #1, #400 and #780. (Volvo Cars Packaging Organization, 2017)

Packaging Type #1: For the wooden packaging solution (#1) we found that the total number of suppliers operating with this packaging type is 358 out of the total 402 suppliers. The majority of the suppliers are based in Europe, with one exclusion based in China. Furthermore, the highest number of suppliers operating with the #1 are based in Germany, followed closely by Sweden (64 suppliers) (Volvo Cars Packaging Operations, 2017).

Packaging Type #400: For the special packaging solution, familiar as the *Combitainer*, (#400) we found that the total number of suppliers operating with this packaging type is 31 out of the total 402 suppliers. The majority of the suppliers are based in Europe, with one exclusion based in Singapore. Furthermore, the majority of the suppliers operating with the #400, both including and excluding Singapore are based in Sweden, followed by Germany (Volvo Cars Packaging Operations, 2017).

Packaging Type #780: For the plastic packaging solution (#780), we found that the total number of suppliers operating with this packaging type is 215 out of the total 402 suppliers. The majority of the suppliers are based in Europe, with one exclusion based in China. Furthermore, the highest number of suppliers operating with the #780 are based in Germany, followed closely by Sweden (Volvo Cars Packaging Operations, 2017).

6.2 Inventory Data

6.2.1 General level

Table 4 on the next page demonstrates the average numbers and calculations of the latest inventory that was completed in November 2016. The table further distinguishes between the three different packaging types. The numbers in the table are based on the findings of the

certain day when the inventory was performed. Please have in mind that decimals have not be considered in the table below (Volvo Cars Packaging Operations, 2017).

Stock take counted stands for the sum of the average inventory *in transit*, at *production plants*, at *supplier* and at *terminal*, and lastly, these numbers are added together to give a total inventory average for every packaging type (Volvo Cars Packaging Operations, 2017).

Outflow stands for how much inventory is flowing out from the supplier, more specifically, the average number of filled packaging before transport leaving the supplier. This number is based on the total average inventory. For instance, packaging type #1 gives us a total inventory average of 515 875, which is divided by the total loop days for #1 (37) and this results in a total average outflow of 13 819 pieces per day, taking every supplier into account (Volvo Cars Packaging Operations, 2017).

Loop days shows how many days in average it takes for the packaging to be in transit, at the plants, at supplier, and at terminal (Volvo Cars Packaging Operations, 2017).

For packaging type #1, the average inventory in November 2016 was 515 874 pieces. What is interesting about these calculations is that they clearly show how most the inventory is located at supplier and also that the supplier accounts for the highest share of the total average loop-time (days). For instance, for packaging type #1, the average number of inventory at supplier is 304 016 pieces, and is located at supplier for 22 days (Volvo Cars Packaging Operations, 2017).

For packaging type #400, the average inventory, is far smaller, however as outlined earlier in the thesis, the demand for special packaging is significantly smaller compared to the standardized types. The average inventory is therefore 18 171 pieces. As was the case with #1, the lion's share of the inventory was this day located at supplier, accounting for 11 040 pieces and the average loop-time for the #400 was 21 days (Volvo Cars Packaging Operations, 2017).

For packaging type #780, the average inventory ended up at 492 364 pieces, with the lion part being located at supplier, accounting for 265 101 pieces. The average loop days at supplier was 18 days (Volvo Cars Packaging Operations, 2017).

Packaging Type	Type	In Transit	Plants	Supplier	Terminal	∑
1	***Stocktake Counted***	85 907	91 702	304 016	34 249	515 874
1	***Outflow***	13 819	13 819	13 819	13 819	13 819
1	***Loop days***	6	7	22	2	37
400	***Stocktake Counted***	3 096	2 091	11 040	1 944	18 171
400	***Outflow***	516	516	516	516	516
400	***Loop days***	6	4	21	4	35
780	***Stocktake Counted***	87 148	108 113	265 101	32 002	492 364
780	***Outflow***	14 525	14 525	14 525	14 525	14 525
780	***Loop days***	6	7	18	2	34

Table 4. Inventory Data, General Level, per Packaging Type. (Volvo Cars Packaging Organization, 2017)

Diagram 1 is meant to give a clearer understanding of the share of packaging that is located at supplier regarding the total sum. For every packaging type, there is more than a third located at supplier, while approximately two thirds are allocated somewhere between the plants, terminals and in transportation (Volvo Cars Packaging Operations, 2017).

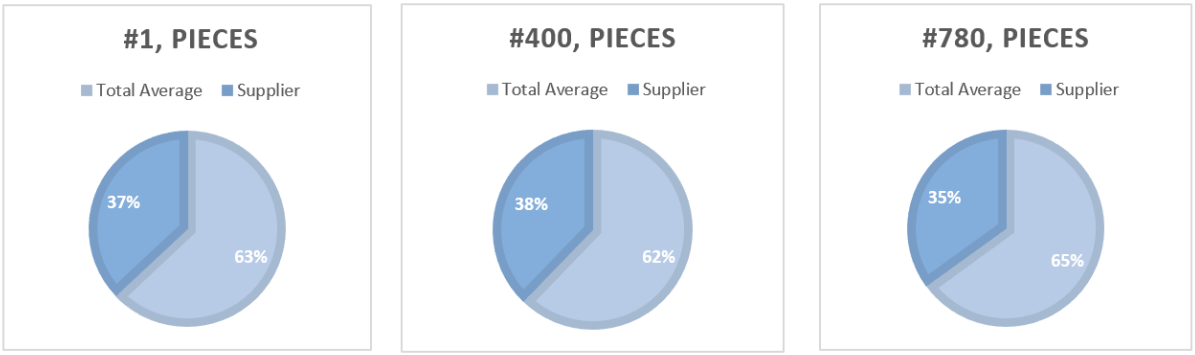

Diagram 1. Distribution of Loop Days at Supplier in Comparison to the Whole Loop. (Volvo Cars Packaging Organization, 2017)

Now that there is a given picture and clearer understanding of the general inventory as of November 2016, the following section will consider the inventory on supplier level. As earlier investigations of this thesis have shown that suppliers from Germany in Sweden are those who operate the most with the chosen packaging types of the study, this section will outline 4 different suppliers and their inventory levels on November 26th, 2016.

6.2.2 Supplier level

The tables below display the inventory levels for November 2016 on supplier level. The four suppliers included in this section are chosen based on the results attained earlier in this chapter, where the findings showed that Germany and Sweden are the countries operating most frequently with the three packaging types. Therefore, this section will be based on the inventory levels of the Swedish suppliers *IAC Group, Skara* and *Supplier Partner* and the German supplier *Magna Mirrors GmbH & Co. KG*.

The reason why these suppliers were chosen and of interest, is based on the fact that these suppliers operate with the highest volumes of packaging. Also, a Slovakian supplier has been included in this section, as the data has been of interest and since Volvo Cars tend to expand their supplier relationships and network by including suppliers from Eastern European countries.

This thesis will not include a description and explanation of what type of material the suppliers are providing the production plants with and the reason for this is that it is out of the scope of the thesis, as it is the packaging levels that are interesting and meaningful.

The tables are further divided by *total inventory on the inventory date*, outflow *of bundles per week, outflow of pieces per week, outflow of pieces per day*, and *lastly the number of days in stock* the supplier has got under its roof (in other words, how many days the supplier will last with the packaging under its roof). The total inventory stands for the total pieces of inventory at the supplier. The outflow of bundles means how many bundles of each packaging type leaves the supplier per week. A bundle consists of different amount of packaging, depending on the type. A bundle of #1 is always$(\boldsymbol{x} * \mathbf{10}) = \boldsymbol{Bundle}$, and a bundle of #780 is $(\boldsymbol{x} * \mathbf{40}) = \boldsymbol{Bundle}$. The #400 is never transported in bundles, due to its size, therefore, there is no equation. Further reading is available in Appendix 2. Outflow of pieces per week is the total number of pieces leaving supplier per week and outflow of pieces per day is the total number of pieces leaving supplier per day, $\boldsymbol{\left(\frac{week}{5} = day\right)}$**.** Lastly, days in stock stands for how much packaging there is under the supplier's roof and how many days it would last.

Some cells are marked with green and red. The green cells mark the days in stock (of a certain package type) that do not exceed 14 days, which is the maximal number of days a supplier is allowed to have under its roof by Volvo Cars. The red cells indicate that the days in stock exceed the 14 days for a specific package type.

IAC Group, Skara	
#1	
Inventory Date (pieces)	13 766
Outflow; Bundle per Week	550
Outflow;Pieces per Week	5500
Outflow;Pieces per Day	1100
Days in Stock	13
#400	
Inventory Date (pieces)	1247
Outflow; Bundle per Week	600
Outflow; Pieces per Week	600
Outflow; Pieces per Day	120
Days in Stock	10
#780	
Inventory Date (pieces)	2379
Outflow; Bundle per Week	26
Outflow; Pieces per Week	1040
Outflow; Pieces per Day	208
Days in Stock	11

Table 5. Inventory Levels at IAC Group, Skara, November 2016. (Volvo Cars Packaging Organization, 2017)

Table 5 above demonstrates the inventory levels for the Swedish supplier *IAC* who operates with all three of the packaging types. The table further demonstrates how *IAC* operates mostly with #1 as the inventory of the same is the highest with 13 766 pieces, followed by the #780 with 2379 pieces and lastly the #400 with 1247 pieces. What is interesting about these findings is that *IAC*, based on the data from the inventory date, does not exceed the 14 days of permitted (by Volvo Cars) days of inventory in stock.

Supplier Partner	
#1	
Inventory Date (pieces)	518
Outflow; Bundle per Week	15
Outflow; Pieces per Week	150
Outflow; Pieces per Day	30
Days in Stock	17
#780	
Inventory Date (pieces)	648
Outflow; Bundle per Week	2
Outflow; Pieces per Week	80
Outflow; Pieces per Day	16
Days in Stock	41

Table 6. Inventory Levels at Supplier Partner, November 2016. (Volvo Cars Packaging Organization, 2017)

Table 6 above demonstrates the inventory levels for the Swedish supplier *Supplier Partner* who operates with two of the three of the packaging types, namely only the #1 and #780. Just like with *IAC*, the data shows how the #1 is most frequently operated with, compared to the 780. The difference between *Supplier Partner* and *IAC* is however that *Supplier Partner* are

exceeding the allowed days in stock and are not respecting the 14-day rule. For #1, the inventory data showed how there is a 17-day stock available. For #780, there is 41 days of stock available – many days over 14.

Magna Mirrors GmbH & Co. KG	
#1	
Inventory Date (pieces)	1 119
Outflow; Bundle per Week	38
Outflow; Pieces per Week	380
Outflow; Pieces per Day	76
Days in Stock	16
#780	
Inventory Date (pieces)	2420
Outflow; Bundle per Week	26
Outflow; Pieces per Week	1040
Outflow; Pieces per Day	208
Days in Stock	12

Table 7. Inventory Levels Magna Mirrors GmbH & Co. KG, November 2016. (Volvo Cars Packaging Organization, 2017)

Magna Mirrors GmbH & Co. KG is the German supplier that has been chosen for this study. Compared to the previous two suppliers, *Magna Mirrors GmbH & Co. KG* operates more frequently with the #780 rather than with the #1 as shown by table 7 above. On the inventory date, there was 1119 pieces of #1 and 2420 pieces of #780. Even though the packaging volume for the #780 is higher compared to the #1, *Magna Mirrors GmbH & Co. KG* still manage to keep the days in stock down to 12. This is however not the case for #1, where the days in stock exceed the allowed 14 days by two days.

Fremach Trnava s.r.o	
#1	
Inventory Date (pieces)	1174
Outflow; Bundle per Week	48
Outflow; Pieces per Week	480
Outflow; Pieces per Day	96
Days in Stock	12
#780	
Inventory Date (pieces)	588
Outflow; Bundle per Week	1
Outflow; Pieces per Week	40
Outflow; Pieces per Day	8
Days in Stock	74

Table 8. Inventory Levels Fremach Trnava s.r.o, November 2016. (Volvo Cars Packaging Organization, 2017)

Fremach Trnava s.r.o is the Slovakian supplier chosen for this thesis and is just like Supplier Partner and Magna Mirrors GmbH & Co. KG only operating with the #1 and #780 as demonstrated in table 8 above. Also *Fremach Trnava s.r.o* operates more with the #1 compared to the #780. The days in stock are significantly higher for the #780 compared to the #1. 74 days in stock is 60 days more than the agreement with Volvo Cars allows. For the #1, the stock days are 12 days.

6.3 Data Comparison - Current and Forecasted Data

This section includes statistical data provided by Volvo Cars Packaging Operations. The data contains information regarding the *packaging demand per type* and *per country* operating with the #1, #400 and #780. The numbers refer to *pieces* of packaging.

In order to improve the balancing of the packaging flow, it may be of importance to weigh forecast data to current data. The reason for this is that the packaging demand may change as the supplier portfolio changes or as new car models are introduced to the market, changing the demand in the production plants. This may therefore call for a different allocation of the packaging, which if done right, can play an important role when wanting to decrease lead times.

This section will therefore include a comparison of data. Data from week 15, 2017 and also forecast data for week 40, 2017 will be compared to see whether the packaging demand is expected to change or not. There is no specific reason why these weeks have been chosen. The countries that will be considered in this section will be those five countries that display the 5 highest numbers in demand of packaging both weeks.

Week 15						
#1			**#400**		**#780**	
1	Sweden	14143	Poland	957	Sweden	5695
2	Germany	4625	Sweden	860	Germany	5572
3	Poland	4481	Belgium	801	Poland	5233
4	Czech Republic	3113	Czech Republic	742	Spain	5114
5	Belgium	2375	Germany	425	France	3856

Table 9. Packaging Demand in Pieces, week 15, 2017. (Volvo Cars Packaging Organization, 2017)

Table 9 shows the demand of packaging (in pieces) for #1, #400 and #780 per country during week 15, 2017. Table 10 below demonstrates the forecasted demand of the three packaging types per country for week 40, 2017.

Week 40						
#1			**#400**		**#780**	
1	Sweden	20199	Poland	1620	Sweden	8859
2	Germany	6749	Sweden	1561	Hungary	5762
3	Poland	6062	Czech Republic	931	Germany	5517
4	Czech Republic	4803	Germany	449	Poland	5189
5	Italy	3100	Belgium	400	Spain	5041

Table 10. Forecasted Packaging Demand in Pieces, week 40, 2017**.** (Volvo Cars Packaging Organization, 2017)

Having the data for both the weeks, it was possible to see where the demand is expected to change the most. Again, the five top countries are included, meaning that for instance, for packaging type #1, the supplier portfolio in Sweden will demand 6057 more packaging pieces week 40, compared to week 15, 2017. What is also interesting is how the top five countries seem to change over this period. For #1, Belgium loses its position to Italy, which also increases its demand by 1700 pieces of packaging compared to week 15, 2017. The overall demand of #1 is according to the forecast data, expected to increase for week 40 compares to the data for week 15.

For #400, Belgium loses its position to Germany, where the packaging demand decreases by (401 pieces. Otherwise, the other countries' position does not change, however, the packaging demand has increased between week 15 and the forecasted week 40.

For the #780, Sweden remains the country with the highest demand of packaging both for week 15 and week 40. Germany loses its second place to Hungary, the country that was not on the top five list at all for week 15. Hungary now shows a significant increase of demand according to the forecasted data. France's suppliers demand decreases according to the numbers for week 4o and the list is instead accompanied by Poland with an increased packaging demand of 5517 pieces. Also Spain's demand decreases marginally, leaving Spain on the fifth place in the list for week 40's packaging demand of #780.

Table 11 is a summary of the difference in packaging demand between week 15 and the forecasted week 40 in order to give a clearer picture of the changes. The table shows how the

#1 will stand for the largest change in demand, where there is an expected increase of 13 151 pieces compared to week 15. For #400, the total change in demand is 1591 pieces and lastly for #780, the total change in demand is 8694 pieces (Volvo Cars Packaging Operations, 2017).

Difference of Packaging Demand Between V15 and V40, 2017 (pieces)							
#1			**#400**			**#780**	
1	Sweden	+6057	Sweden	+702		Sweden	+3164
2	Germany	+2123	Poland	+663		Hungary	+2769
3	Italy	+1700	Czech Republic	+189		China	+1181
4	Czech Republic	+1690	Germany	+25		Romania	+901
5	Poland	+1581	Italy	+12		Morocco	+679
∑	**#1 = 13 151**		**#400 = 1591**			**#780 = 8694**	

Table 11. Differences in Packaging Demand between week 15 & 40, 2017. (Volvo Cars Packaging Organization, 2017)

6.4 Group Discussion Outcome

On the question regarding why the employees thought the loop-time today is unbalanced, the answer was that the employees believe that the suppliers keep the packaging too long under their own roof. It is kept way longer than 14 days, which is the longest period allowed. It was also stressed that the transporters of the packaging are given more time that they need and can therefore end up waiting to unload and load, which further increases the lead time from one point to another. Sometimes, transporters who can reach a destination in 3 hours, are given 24 hours. It also happens that the carriers transport their loads to consolidation centers or hubs and pick it up the next day. This together with the supplier keeping the packaging longer than they are allowed are according to the employees the main reasons why the loop-time is unbalanced.

They main reason for the suppliers keeping the packaging under their roof is because they simply want to have a stock level high enough for them to avoid being left without any packaging at all. The suppliers are many times located in other countries than in Sweden, meaning that some suppliers may work during holiday weeks and other public holidays when Volvo Cars is closed and may therefore order more than they actually need, resulting in packaging being slowed down in the flow and an increased loop-time.

Some packaging types are used more than others, meaning that inventories might be higher than they should, however they cannot be terminated as they are still being used, although

perhaps less frequently. There may be some special packaging types that are not used anymore and may take inventory space for no reason. Also, certain packaging types are sometimes prioritized more than others, meaning that when more attention is given to a certain packaging type, the other types are more or less left behind and this gives incentives for increased lead times.

The aftermarket is a further reason to why a lot of packaging is tied up. As an example, the car model V70 is not produced anymore, however the aftermarket still requires the packaging to be available, resulting in increased inventories. Some suppliers stock components for older models under their own roof, however it often happens that they do it in Volvo Cars Packaging solutions as it is easier for them, rather than unpacking and packing again. This is however not legal, but at the same time it is difficult to trace every packaging piece. The variation of performance in the production plants is a further reason contributing to the loop-time. Once the factories are facing difficulties, the material still arrives and this further results in packaging being tied up in the factories and is not moved forward until empty.

There is an ongoing improvement of the container management system that is used today, and the goal is to improve and create a system where restrictions can be made towards the suppliers in terms of packaging volumes. This way, it will help with preventing high lead times and tied up packaging. Once the suppliers have reached their order limits they will not be able to order any more packaging. According to the current policy, the suppliers are only allowed to keep the packaging for maximum two weeks in their plants, meaning that they are often violating their agreements. Even though Volvo Cars Packaging are aware of this problem and, it is difficult to find evidence and material confirming such violation. To solve this problem, documentation would be needed from every supplier Volvo Cars is facing difficulties with. This would require a lot of extra work, such as contacting every supplier and getting valuable information from them and this is certainly outside the actual working plan.

Sometimes the statistics available at Volvo Cars may not always be the same at the supplier, meaning that there can be some technical misunderstandings as well. The stock balance can therefore differ between Volvo Cars and supplier. It occurs that orders in one system that is used, have not been registered in another system used, resulting in miscalculations and differences. According to the employees of this discussion, there are many investigations that need to be done and many variables to consider, however, time is not on their side. The

variation of performance in the production plants is a further reason contributing to the loop-time. Once the factories are facing difficulties, the material still arrives and this further results in packaging being tied up in the factories and is not moved forward until empty.

It is always easier to work with packaging once the annual inventories are completed and there are fresh calculations available to work with. This way, there is no room to blame the systems or miscommunications, since you have fresh data. A problem that may arise and affect the data severely is how well the system that helps counting is performing. There are two inventories per year, one of them of legal purposes and the other one on the behalf of Volvo Cars.

The internal communication is believed to work fine, as there is a frequent communication both within and between teams. Being seated under the same roof also facilitates the communication. Most importantly, there are daily evaluations of the status, giving the employees an overall picture. There are however difficulties concerning communication between organizations, such as Outbound Logistics, responsible for ordering the transports of the packaging. This problem has already been thought of and there are plans to move the two organizations and place them under the same roof under 2017, which hopefully will improve the communication and performance. A severe problem between the two organizations is that Outbound Logistics wants to keep their transportation costs down, while the Packaging Operation's goal is to keep the loop-time low. A longer transportation often means less money, however, for packaging this results in increased loop-time, with tied packaging. An interesting dialogue needed is how to balance cost and time – this can contribute very much to an improved loop-time.

The communication from the suppliers towards packaging often concerns them needing help or if they have questions to their advantage. It is very rare to have a supplier to get in contact to say that they have too much packaging under their roof. If this happens, it is often because they do not have any more storage room for the packaging. Overstocking is generally not a problem to the suppliers. Once Volvo Cars investigates suppliers that obviously have overstocking under their roof, they will be contacted and confronted about the issue, and the answer is often "*Oh, is that so? Well, can you then help us reduce some orders*?". Once again, there is a lack of control over the situation at the supplier as well. The larger the supplier, the more lack of control.

Communication is sometimes a hurdle, as there is a daily contact with suppliers outside the Swedish borders. Often, suppliers are lacking knowledge in English, resulting in a frequent usage of Google Translate and other facilitating tools. Germany and France for instance, prefer their native languages before English, which often results in lingual difficulties. Officially, according to Volvo Cars, the communication is supposed to be in English. These lingual difficulties may also result in suppliers avoiding contact as it is too intimidating. Not to be forgotten is that many suppliers have their designated employee for communication of this type, so if it is the same person in question, it is often not a problem in terms of communication. The split from Volvo Logistics, explained earlier in this thesis, has also lead to confusion as the same packaging is no longer used jointly by Volvo Group and Volvo Cars. Suppliers often get confused when making orders, thinking that packaging is available regardless if it is from Volvo Group or Volvo Cars. Still, three years later this confusion remains.

The level of availability of the suppliers is relatively stable. It occurs that they are hard to reach, however it is not a severe problem. Furthermore, the packaging organization is working with "tickets", meaning that, if a supplier has a question or concern they place a so-called "ticket" which places them in line to the packaging operation support team to help answer their question. The tickets are processed sequentially. If Volvo Cars tries to get in touch to "solve" the ticket, and there is no answer from supplier, the question will be closed and considered solved, or if needed, the problem is escalated to the higher management. Administrative reports are in some situations sent out as a fine to supplier if they have not been in touch when expected too.

It is believed that the suppliers many times are provided with too much information and sometimes the wrong approach is made of how the collaboration is supposed to be conducted. Initially, the guideline and training material was massive and has over the years, due to learning difficulties been decreased. The guideline teaches suppliers how to handle CMS, but too much material also means that it will not be read properly. Other possible problems could be that there is often one or few people responsible for a lot of tasks, resulting in the supplier being highly dependent on a small number of employees. This could easily turn into a severe problem if these people were to quit, get ill, etc. The level of competence of the suppliers is a fact, this depends on size and experience.

Looking at the situation historically, suppliers that have been collaborating with Volvo Cars (and Volvo Group logistics earlier), know that the service level has not always been the best. This could be one reason why many suppliers do overstock, as they may lack trust towards Volvo Cars and their performance, even though it has been improved.

As discussed, the main possible reasons for the unbalanced loop-time as of today is the system performance and the transportations and their management and goals, not fitting with the management and goals of packaging as much as it should. The dream scenario according to the employees participating in the discussion would be suppliers working perfectly with both the Container Management System and the Transport Management System. It is important to train the suppliers properly from the beginning and teach them to be proactive and have control over the systems prevent and avoid misunderstandings. Often, the information is there, available to them, however there is sometimes a lack of control of the information and data given to them.

Most importantly, the different teams are not affected differently by problems that may arise as they are working towards the same goal – to keep the production plants going and to enable cars to be built. Teams might have different amount of work to do, depending on what needs to be solved but in the end, it will help everyone.

7. Analysis

The analysis will be based on the models, theories and previous research that have been presented, as well as the conducted and compiled information from the "empirical findings" chapter. An analysis related to the significant qualitative factors mentioned in the SERVQUAL- and CATWOE-model will be included to highlight potential gaps, deviant factors or issues that may be highly prominent. A discussion of the empirics in regards to relevant past research within the field will further be analyzed.

7.1 Packaging in an Automotive Industry

It is safe to say that a packaging demand will remain as long as there are functioning logistics activities, regardless if it is a classic supply chain or a supply chain aligned more with the current trend of reusable packaging, (Molina-Besch & Pålsson, (2014); Bowersox et al, (2002); Rushton et al (2014), with production plants in need of sufficient components and materials needed for assembly. The unit load concept as argued by Rushton et al (2014) has facilitated this kind of operations and has improved and enabled a more synchronized flow of packaging, leading to cost savings on several fields.

The automotive industry, using Volvo Cars as an example is due to following the lean management concept (Antony, 2011) constantly under cost reduction pressure (Bowersox et al, 2002), yet expected to deliver high quality products to its end customers. Volvo Cars reflect these factors in their operations, where also the use of standardized packaging has helped to achieve a synchronized flow in the loop, a factor also highlighted by Rushton et al (2014). Although, managing packaging in a large corporation does require much more than optimized packaging solutions and it can easily fall out of balance (Rushton et al, 2014) in different ways. Volvo Cars Packaging Operations does not have many years of history, and it has been a long road to align and manage the network that exists today, however, even the sun has its spots, and this operation found these spots in the balancing the packaging flow in the loop. Aligning the processes both internally and externally is therefore of high importance for a balanced network and packaging flow.

Volvo Cars Packaging Operations have only by working according to the shared mode highlighted by Zhang (2015) and by centrally managing the packaging with its teams, been able to control and keep the safety stocks down, compared to the opposite that would mean much less control over the loop. Also by incorporating second and third tier suppliers into the supply chain has shown significant cost benefits, accordingly to Twede & Clarke (2004). When considering investment decisions, Volvo Cars Packaging Operations are constantly

handling a lot of statistical data, elaborating further on results, inventories, forecasts, aligning with Bowersox's (2002) statement that a financial analysis needs to be based on net present values, to give an accurate picture of the circumstances, which leaves us with the question; what more can and should be done? Where are the bottlenecks of the process?

Using Volvo Cars Packaging Operations as an example for this study and how has enabled a deeper understanding of the complexity of a company's packaging process. The main goal that is constantly sought to be achieved, is to reduce lead-times and avoid abnormalities in the packaging flow. A significant challenge in this process, has in our research occurred to be the transportation taking the packaging from A to B. The reason why is that a packaging operation's goal often is to keep the lead times down, while for the transportation operations it may be of higher significance to keep the costs down and therefore choose a transport option that takes longer time, maybe by stopping many times on the way to fully utilize the truck, an aspect reflected also by Mckerrow (1996). This however results in higher lead times for the packaging operations which is not sustainable for the packaging flow. This issue was highlighted in the group discussion, where this mismatch and lack of integration may cause difficulties and result in hours lost. The transportation issue will be discussed further down in the analysis.

7.2 The inventory

Using and investigating a company's inventory data taught us one very important thing. As the tables in section 6.2 present, the inventory can be counted as done by Volvo Cars Packaging Operations; in transit, in plants, at supplier and at terminal, which has enabled and helped us to see where there is a possible bottleneck. The results of the inventory show how most of the packaging on that day was located at supplier, also indicating that the lion part of the loop-time that is wished to be decreased is due to the packaging staying for too long at supplier. For all three packaging types, the total loop-days were slightly over a month, and considering the results of the majority of the suppliers being located in Europe, it clearly shows that there is a severe bottleneck somewhere in the loop. The inventory data undoubtedly shows how this bottleneck is at supplier. The permitted 14 days are far exceeded on every packaging type, indicating that this may be a rather extensive issue. Obtaining a well-balanced inventory management is greatly beneficial as mentioned by Wild (2002). The inventory values can decrease, the use of endeavors can be limited and the customer service level can increase. The issue today that was presented by the employees is that the suppliers

keep the packaging for too long, exceeding the 14 permitted days. Another contributing factor was that the transporters time given is more than the actual time needed which allows room for an elongation of the lead time. Even though it is clear that the suppliers violate the contracts by keeping the packaging longer than allowed, there are some difficulties when finding evidence that proves that this is the case. Data from the suppliers will be needed and this is very time consuming, and this is work outside the scope according to the employees.

As the most severe bottleneck on a general level was found to be the supplier, the inventory was further investigated on supplier level as explained in the empirics, which also confirmed the bottleneck with the results found on general level. It would be wrong to state that every supplier is a contributing factor to the high loop-time as there clearly are suppliers that are doing very well. One example that could be used as a role model is IAC Group, Skara. If every supplier was to work accordingly to them, the loop-time problem would perhaps not be completely solved, but it would be a very constructive path to follow. Taking Supplier Partner as an example, being located in Sweden, it would be unwise to blame the problem on distance. Magna Mirrors GmbH & Co KG, located in Germany is according to the results having less problems than Supplier Partner, despite the larger distance.

Wild (2002) discusses how inventory control manages the availability of demanded items for the customers in the marketplace and facilitates the coordination of purchasing functions, manufacturing functions and distribution functions. Although, the numbers that are available for Volvo Cars Packaging Operations do not always correspond to the numbers that the suppliers withhold, which results in technical misunderstandings. If Volvo Cars Packaging Operations acknowledge a low amount of packaging at one supplier, they will send the amount that is needed, while there in fact might not even be a low amount of packaging at the supplier. This could depend on not updated numbers and inadequate information.

Since the suppliers tend to keep the packaging because they want to have a higher stock level they believe that they can respond to future demand variability, supply reliability or transport dependability, if they arise. A situation where there is no packaging available at all, is something the suppliers want to avoid according to the group discussion. Because of higher stock levels, the loop-time increases since the flow of packaging slows down. Wild (2002) argues that when the amount of stockholding matches the amount of demand is when the inventory is at its optimal level. Although having a safety stock is positive in situations where

unexpected variations in demand may occur, but high levels of safety stock are not preferable in this closed-loop packaging operations where the objectives are dependent on each other.

Having good communication skills and professional stock techniques will result in higher inventory control (Wild, 2002). There is an existing issue with a lack of control on the supplier side, since there have been situations where suppliers have been overstocking and not been aware of it until Volvo Packaging Operations contacts them and informs them. Having higher control over situations like these will lead to lower costs, which in hand will lead to a lower stock level (Wild, 2002). Since CMS is provided to reach cost optimization by reducing safety stock levels, lead times, and reduction of additional shipments, situations like the previous mentioned should be avoided.

7.3 Current and Forecasted Data

When considering the data regarding demand both in terms of current data and forecasted data, again the results show that the countries requesting highest packaging volumes are located in Europe. The results also indicated how quickly demand can change and how the significance of a country's suppliers can change. When looking into the supplier portfolio, Hungary was pretty low positioned, when looking at table 1, but the demand on the Hungarian is expected to rise significantly, considering the forecasted data. The reasons for this could be many; there is a goal at Volvo Cars to expand their supplier portfolio towards Eastern Europe, and, as the market constantly is changing and Hungary may possess suppliers needed for future models, while those supplier that have been important so far, are not as accurate. Looking at table 11, Morocco, as a Northern African country is growing of importance which is quite alarming as the packaging volume is pretty low. Is it necessary to source from another continent if it is for a low volume, or is it a matter of a misbegotten sourcing strategy? Logically, the sourcing strategy should be aimed towards the suppliers that are operating with the highest volumes, while only prioritize the suppliers with low volumes only if supplier proximity is considered first. If this is not an answer, as the supplier delivers material of high importance, then proximity does not need to be considered to the same degree.

So, what is there to learn from a company's own corporate data? Volvo Cars constantly elaborates, on a whole, lots of data, and the choice of data itself is a challenge. Difficulties may occur in regarding which end to begin with, but continuously looking into inventories, current and forecasted data is of high importance when wanting to facilitate the allocation of

packaging but also to control the status. The inventory gave an insight of the supplier platform structure and how the packaging flow is distributed in the flow which made it easier to evaluate more on the problem. The overall supplier platform does not necessarily seem to be an issue as there is clear indications that supplier proximity is of importance, which itself does keep the total loop-time down, however the underlying problem of the unbalanced loop is according to our findings found at the supplier, where the loop-days are the highest, hence why the best solution to the problem would be to focus on the supplier's operations which certainly is easier said than done. It would require a massive engagement of resources to investigate the operations of every critical supplier, however, considering the findings, we believe it would be the optimal long term solution.

Looking at the other pillars contributing to the loop, they may not be affecting the loop-time to the same degree and may not lead to the most ideal solution, but half a loaf is better than no bread at all, and it is always an initial point to go from and learn something on the way. Figure 7 on the next page highlights in red the most critical pillar of the loop, but what about the rest of the pillars? The transports, as discussed earlier, can be affected, but the main difficulty lies in different operation goals, where time needs to be balanced with cost management. The packaging and inbound logistics are in the close future moving together under the same roof to better integrate their operations. If the communication and integration, considering Jacobs et al (2016) study, is affected positively due to this merge, it could mean more than an improved transport lead time, where also the external integration would be affected. As the transport is not the most critical factor of the loop, this would not lead to a remarkable change in the loop, however, it would be something to stand on. As the two organizations currently collaborate under different roofs, an integration of moving together would facilitate the communication and hopefully give incentives for an improved performance, where it could also be easier to affect the exceeding loop-days at supplier.

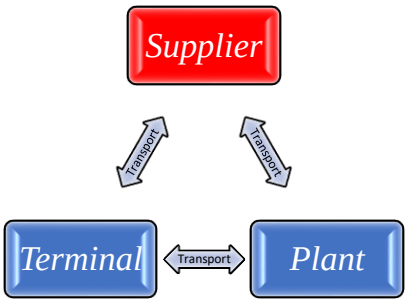

Figure 8. Packaging Loop. (Volvo Cars Packaging Organization, 2017)

7.4 Supplier Proximity

Using the three packaging types as a base for the analysis of the empirical findings, the results found have enabled an analysis of the supplier portfolio at Volvo Cars Packaging Operations. It is clear to see that the major part of the supplier platform is located in Europe, which is of importance when considering lead-times and supplier proximity. This is well connected to lean management and Antony's (2011) statement "*to produce products and services at the lowest cost and at the fastest pace possible*" where proximity does enhance lower lead times and allows low costs if sourcing is done properly. The empirical findings further show how also China is an important country with many suppliers connected to the packaging operations, however, also here proximity has been taken into consideration as there is a deviating rule for China and Japan. The suppliers shipping material and components from China and Japan are firstly shipping to a hub or consolidation center and stocked there until there is a demand from Volvo Cars. The hubs and consolidation centers therefore work as Asian suppliers on European ground, mainly to avoid extensive lead times and quick replenishment. As there are countries outside Europe besides China and Japan, that may provide material from one supplier only, such as Korea, Vietnam, Taiwan and India, this does seem to align completely with the lean management concept. The transport would mean terrible lead times, and to source from countries that far away is not sustainable if it is only one supplier involved, as the results highlight. Flexible and customer controlled flows could be improved by reconsidering the supplier portfolio. What is important to have in mind is that the thesis has only considered three packaging types, however, three of the most important ones, which can make one think whether there is a sourcing issue to have an extra look at.

7.5 Theory and Models

Using the determinants presented in the SERVQUAL-model it is possible to acknowledge some inconsistency within the packaging operations. To begin, there seems to be a low amount of *reliability*, where there are some performance issues. As mentioned earlier, the group discussion highlighted that the suppliers work differently, some keep the packaging under their roof for an extended time than what has been agreed, while other manage to keep their part of the agreement and deliver within the expected timeframe. Due to various circumstances, there are some experienced difficulties regarding the delivery of packaging. Although, the suppliers receive the amount of packaging they have ordered, the packaging that later is sent to the factories may not be the same number, which often is an indication of overstocking. Having many factors affecting the packaging process makes it harder to balance

the whole operation, for instance, the carriers, the suppliers, the factories to mention a few, all have a resulting impact. Moving on to *responsiveness*, it appears that linguistic issues are of concern as some supplier countries prefer to use their native language due to lack of English skills. Also, the ticket system used when questions are raised by the suppliers will always be answered. What needs to be highlighted is that the supplier's responsiveness seems to be weaker than the responsiveness of the packaging operation department. It is of great importance that effective and stable communication relationships must be built in order to increase performance levels according to Prahinski (2007). As discussed by Zsidisin et al (2015) and Jacobs et al (2016), the internal integration is positively connected to supplier integration, which is why we believe that if a stable internal communication is held at a balanced level it will evolve into a reliable supplier performance. The supplier involvement, considering the empirics is very common and on a high level. The supplier communication and packaging support teams' direct contact with the suppliers is of great significance as there is a two-way communication needed to keep the flow in order, which also connects to Molina-Besch & Pålsson's (2004) argument of common supplier involvement, with the main reason being technical support. The supplier communication enables a fast communication flow

Tangibles, considering responding to the suppliers needs, which are met through delivering the desired amount of packaging. Also, when Volvo Cars Packaging Operations provide CMS as a tool for the suppliers to place orders and exchange information with Volvo, this also requires the need for a proper education platform for using the system. This system should facilitate the process, but there are some evidence proving that the CMS guidelines were too heavy which have created some issues, but improvements have been integrated during the recent year. Being a small department with 16 employees could disfavor the service tangibles since there are a few people the suppliers are dependent on. If a situation would occur where the responsible employee would not be present to handle it, this could cause a reduction in the service quality. Nevertheless, due to recurring linguistic issues, the hospitality may not be experienced as well as they would if there were no language barriers. This affects the feeling of *assurance*. The employees mention how the education of CMS has not been as comprehensive for the suppliers as it has been for them, and this has increased the feeling of shortage of skills and knowledge possessed by the suppliers, influencing the *empathy*. Due to the development of complex supply chains which exists within the automotive industry, the need for computer-based communication is crucial (Cutting-Decelle et al. 2007).

In situations where there are several stakeholders, the tool CATWOE will help analyze, reveal and manage problems, if they exist. In the investigation of Volvo Cars Packaging Operations, it is obvious that the *customers* are the actual customers of Volvo Cars. While the *actors* are the stakeholders, which includes every supplier, every terminal, every factory, the carriers, all the employees at Volvo Cars Packaging department and the customers. If the goods are not delivered in time, there will be difficulties with the production in the factories. Since the packaging operations are in a closed loop, the possibility of a chain reaction is higher, which means if an abnormality occurs at supplier, the risk of it affecting the other components in the loop is more likely to occur. As Battini et al (2017) argues, a closed-loop management comes with complexity in many activities. The management of inventories requires well-functioning systems, as stated by Bowersox et al (2002) and Volvo Cars Packaging Operations reflection of this is how the company relies heavily on the CMS and requires their supplier portfolio to incorporate it as well to align the process and avoid errors in the packaging orders, flow, stock, etc.

As previously mentioned, all stakeholders have different objectives and different goals, in other words, different *worldviews* (Checkland, 1999), but one thing they do have in common is the aim for efficiency. The need of having a cooperative relationship with suppliers of high significance is increasing and through the evaluation of the various stakeholders would in fact facilitate the ambition of meeting the performance and objective goals (Prahinski, 2007)**.** The lack of efficiency usually results in a decrease in profitability. The employees further discussed how a possible reason for an unbalanced loop-time could be due to the management and goals of the system performance and the transportations not being aligned with the management and goals of packaging operations.

Moreover, the *owners* who make all the investment decisions and pursues projects is the Volvo Cars Packaging Operations. By forecasting demand and other essential objectives for a well-balanced flow, they become the beneficiaries for a stabilized supply chain process. Lastly, the element *environment* can be linked to the use of lean management which is highly prioritized by Volvo Cars Packaging Operations. Incorporating the lean mind-set explains the devotion in being efficient regarding time and resources, since it not only is a way of thinking but it also focuses on customer satisfaction as well as waste elimination Antony (2011). Rushton et al (2014) further explained how unit loads have helped to reduce unnecessary storage, transportation and distribution costs related to packaging. Inquiring unit

loads will have a positive effect on the environmental factors, by decreasing lead times, allowing cost management and shortening the transport needs.

7.6 Volvo Cars Lean Management

The strive towards incorporating lean management at Volvo Cars is an important factor of the operations. Through this research it has come to the conclusion that there are some possible factors which do not necessarily match the lean management. Firstly, the results gained in the empirical findings taught us that even though the supplier was found to be the critical component of the packaging loop, there are yet measures that could be taken by the company itself to prevent abnormalities from their side. For instance, a higher control of the exceeding orders and safety stock at supplier is needed as there is a lot of tied-up capital as this is opposing the aim towards lean management. Secondly, the 14 days which should be respected by the supplier are very often not, therefore the contractual agreement should be harder looked upon and also implement higher fees of delay should be considered.

8. Conclusion

This chapter will give an overall summary of the analysis that has been conducted in this study as well as account for the previous research within the field of packaging operations of a company and the different components that contribute to the process. The aim of the study was to investigate the possibilities and hurdles that may affect an automotive company's packaging operations and to reveal possible gaps within a closed packaging loop. Our findings have resulted in a clearer view of the current situation at Volvo Cars Packaging Operations. These findings will hopefully contribute to further research within the subject.

8.1 Gap 1: Supplier

Firstly, the most critical bottleneck in light of the packaging loop at Volvo Cars Packaging Operations, has been found to be on supplier level. The results gained through this study, has by investigating the company's own data, confirmed that the actual cause of the exceeding loop-time today is a result of poor coordination and management at the supplier. Nevertheless, as previously mentioned, affecting the supplier and its management is clearly difficult to influence, as it would require an extensive use of resources and time. However, viewing the situation from a long-term perspective, it would be of importance to consider the supplier engagement, as it could benefit the packaging loop-time, leading to an improvement of the operations. Considering the theories applied and the results given, there are both tangible and intangible factors that could be improved and contribute to more balanced activity between a Packaging Operation and its supplier platform.

A further critical issue within a closed-loop supply chain has further appeared through the bottleneck lying at the supplier. It is clear too see that it is hard to avoid a chain reaction of the consequences caused under the supplier's roof. Unfortunately, this will influence the other components of the loop, such as the transportation from supplier to production plant, and most likely cause production downtime at the plants due to certain material and components not reaching their end destination on time. Lastly, the implementation of lean management is not completely flawless mainly due to lack in control regarding safety stock levels at supplier and the limited evaluation and discussion of applying higher fees for exceeding the allowed 14 days of stock located on supplier ground..

8.2 Gap 2: Supplier Proximity

The supplier portfolio consists of suppliers that are many times located far from their end-location, such as in Asia, Africa and North America. The critical issue with was found to be that these countries are often operating with one or few suppliers, which further require small volumes of packaging. Therefore, a suggestion would be that it would be wise to consider the

supplier network, and contemplate whether the small volumes required, are worth the cost of time the distance means, or if the supplier network structure can be changed and if the same material and components can be sourced from a supplier located closer to the end-destination, as this would most likely have a positive impact on the loop-time. Supplier proximity, together with an improved supplier control, as discussed earlier, would together result in a constructive solution.

8.3 Gap 3: Transport

Considering some significant stakeholders, there are some issues of concern. For instance, the balance of cost efficiency and time efficiency, where the findings show a mismatch between the interest of the packaging operations and the transport operations of the company, should be used as an example when aiming for a more integrated process. There needs to be an improved collaboration when transporting the packaging from one point to another, and try to utilize the trucks by stopping fewer times, if possible, in order to avoid delays in the loop. This way, both cost-management and time-management will be considered. Volvo Cars Packaging Operations have indeed acknowledged this issue and by merging the organization, it is expected to eliminate difficulties such as miscommunication, as well as lack of empathy and internal integration.

8.4 Gap 4: Communication

As the Packaging Organization consisted of 16 employees, this example should be applied to similar studies as the results gained in this study cannot be generalized and applied to larger packaging organizations. The internal communication was found to very strong and was shown to be one of the stronger features of the organization, where there was a significant responsiveness and collaboration throughout the hierarchy. Frequent meetings and updates does give an organization incentives for an integrated communication ground. One external communication issue discovered is the low responsiveness from the suppliers. For instance, CMS should be used to facilitate the communication and information reaching and it is not utilized to its fullest potential, which raises concerns.

Even though it is stated that it is difficult to manage a supplier situation discovered in this study, our findings have shown that there are some elements that can lead to improvements. For instance, stricter regulations regarding language skills should be applied in order to avoid language barriers, which can lead to miscommunication and unnecessary misunderstandings. Another external communication issue revealed in the analysis, is that due to lack of control at supplier, and resistance to communicate with Volvo Cars Packaging Organization to the

fullest, can lead to certain situations where a problem is addressed very close to the point where it is almost too late. This forces the packaging organization to step in with guidance and help solving the issue which often is out of their time scope, resulting in other more urgent tasks suffering. Therefore, the suggestion to improve this problem would be to have more frequent evaluation and feedback opportunities, where potential problems can be addressed before it evolves into a consequential case.

In conclusion, the research question of this study can be answered as follows; the network balance is the most critical at supplier, since the highest share of the loop-time is found there. This is also the share, which if affected by the willingness of placing high investments, would lead to the most beneficial solution in the long-term. The network balance is also negatively affected by communication barriers, which if solved, would not lead to remarkable changes to the current network as there are more critical objectives to be addressed. The internal integration issues that exist have led to unbalanced transportation performances in correlation to the packaging operations goals, however is expected to be improved by following Volvo Cars Packaging Operations example of moving together under the same roof with the inbound logistics organization.

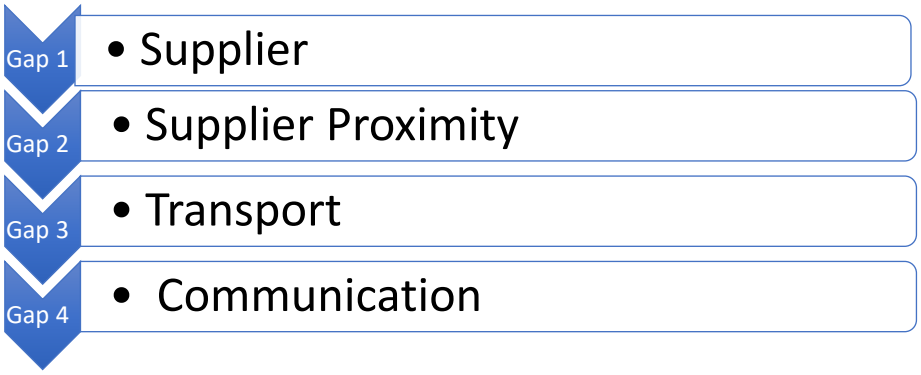

Figure 9. Overview of the flow of the Gaps (Author's own depiction, 2017)

8.5 Suggestions for Future Work

There are several possibilities that can be considered to give a broader answer to the research question. As the data used to conduct this thesis has been narrowed down, there is room for further research where more data can be analyzed and more factors and variables incorporated. It would have been interesting to dig a few steps deeper into the supplier portfolio and investigate other possible factors that may affect the loop. Furthermore, it would be interesting to see if a quantitative approach of the same problem would provide the same conclusion or contribute to deeper findings and give a wider overview of solutions. The use of

time-series data could maybe further give a more precise conclusion. The innovation and technology is constantly developing and the automotive industry must follow the same pace. As Zhou et al. (2017) study investigates inventory variance at manufacturer and supplier, this study could be of use for future research.

References

Antony, J. (2011). Six Sigma vs Lean. *International Journal of Productivity and Performance Management*, Vol. 60 Iss 2 pp. 185 – 190.

Banker, Steve. (2010). *The importance of packaging in supply chain management*. Available at:<https://logisticsviewpoints.com/2010/06/21/the-importance-of-packaging-in-supply-chain-management/ > [Accessed: 170315].

Battini, Bogataj & Choudhary. (2017). Closed Loop Supply Chain (CLSC): Economics, Modelling, Management and Control. *International Journal of Production Economics*, 183, pp.319–321.

Bowersox, D.J., Closs D.J., & Cooper M.B. (2002). *Supply Chain Logistics Management*. New York, NY: McGraw-Hill/Irwin.

Checkland, P.B. (1999), *Systems Thinking, Systems Practice: Includes a 30-Year Retrospective*. Chichester: John Wiley & Sons Ltd.

Collis. J and Hussey. R. (2013) *Business Research. A practical guide for undergraduate & postgraduate students*, Palgrave Macmillan

Cutting-Decelle, A.-F.F. et al. (2007). A review of approaches to supply chain communications: From manufacturing to construction. *Electronic Journal of Information Technology in Construction*, 12, pp.73–102.

Droge, Jayaram & Vickery. (2004). The effects of internal versus external integration practices on time-based performance and overall firm performance. *Journal of Operations Management*, 22(6), pp.557–573.

European Commission. (2017). *Packaging and Packaging Waste*. Available at: <http://ec.europa.eu/environment/waste/packaging/index_en.htm> [Accessed:170320]

Fall, S. (2017). *Corporate Strategy, Mission & Objective*. PowerPoint Presentation. Volvo Cars. Gothenburg, Sweden.

Greasley, S. (2016). *Packaging Lead Time – Time is not always on your side*. Available at: <http://howtobuypackaging.com/packaging-lead-time/> [Accessed: 170315].

Guide, V. Daniel R., Jr., Harrison, Terry P. & Van Wassenhove, Luk N. (2003). The challenge of closed-loop supply chains. *Interfaces*, 33(6), p.3.

Hellström, D., & Johansson, O. (2010). The impact of control strategies on the management of returnable transport items. *Transportation Research Part E: Logistics and Transportation Review*, *46*(6), 1128-1139.

Humphrey, J., & Memedovic, O. (2003). The global automotive industry value chain: What prospects for upgrading by developing countries. *UNIDO Sectoral Studies Series paper, Vienna.*

Inet-Logistics. (2017a). *Inet Logistics – Company*.
Available at: <https://www.inet-logistics.com/en/company/> [Accessed: 170214].

Inet-Logistics. (2017b). *Inet Logistics – Clear Container Management*. Available at: <https://www.inet-logistics.com/en/solutions/container-management/> [Accessed: 170214].

Inet-Logistics. (2017c). *Inet Logistics - Efficient Transportation Management.* Available at: <https://www.inet-logistics.com/en/solutions/transportation-management/> [Accessed:170214]

ISO. (2005). Information technology – unique identification – part 5: unique identification of returnable transport items (RTIs). *Working draft, ISO/IEC 15459-5*.

Jacobs, M., Yu, W. & Chavez, R. (2016). The effect of internal communication and employee satisfaction on supply chain integration. *International Journal of Production Economics*, 171, p.60.

Johansson, O & Hellström, D. (2009). The effect of asset visibility on managing returnable transport items. *International Journal of Physical Distribution & Logistics Management*, 37(10), pp.799–815.

Kumar & Putnam. (2008). Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors. *International Journal of Production Economics*, 115(2), pp.305–315.

Kroon, L & Vrijens, G. (1995). Returnable containers: an example of reverse logistics. *International Journal of Physical Distribution & Logistics Management*, Vol. 25 Iss 2 pp. 56 –68.

Lumsden, K (2012). *Logistikens Grunder*. Lund: Studentlitteratur.

Lützebauer, M. (1993). *Systems for Returnable Transport Packaging (in German: Mehrwegsysteme für Transportverpackungen)*, Deutscher Fachverlag GmbH, Frankfurt am Main.

Mangan, John, Chandra Lalwani, and Chandra L. Lalwani. (2016). *Global logistics and supply chain management*. John Wiley & Sons.

McKerrow, D. (1996). What makes reusable packaging systems work. *Logistics Information Management*, 9(4), 39-42.

Molina-Besch, K., & Pålsson, H. (2014). Packaging for eco-efficient supply chains: why logistics should get involved in the packaging development process. *Sustainable logistics. Transport and Sustainability*, 6, 137-163.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985), A conceptual model of service quality and its implications for future research. *Journal of Marketing*, Vol. 49.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988), SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality, *Journal of Retailing*, Vol. 64 No. 1, pp. 12-40.

Patel, P. (2017). *Transports of Empty Packaging*. PowerPoint Presentation. Volvo Cars. Gothenburg, Sweden.

Prendergast, G., & Pitt, L. (1996). Packaging, marketing, logistics and the environment: are there trade-offs?. *International Journal of Physical Distribution & Logistics Management*, *26*(6), 60-72.

Prahinski, C. & Fan, Y. (2007). Supplier Evaluations: The Role of Communication Quality. *Journal of Supply Chain Management*, 43(3), pp.16–28.

Ristenstrand, E. (2016). *Volvo Cars Packaging Operations*. PowerPoint Presentation. Volvo Cars. Gothenburg, Sweden.

Rushton, A., Croucher, P., & Baker, P. (2014). *The handbook of logistics and distribution management: Understanding the supply chain*. Kogan Page Publishers.

Silva, Diogo Aparecido Lopes et al. (2013). Comparison of disposable and returnable packaging: a case study of reverse logistics in Brazil. *Journal of Cleaner Production*, 47, pp.377–387.

Smyth, D.S. and P.B. Checkland. (1976). Using a Systems Approach: The Structure of Root Definitions. *Journal of Applied Systems Analysis*, Vol. 5 No. 1, pp. 75-83.

Sundar Raj, T., Lakshminarayanan, S. & Forbes, J. (2013). Divide and conquer optimization for closed loop supply chains. *Industrial and Engineering Chemistry Research*, 52(46), pp.16267–16283.

Tsoulfas, G. T., & Pappis, C. P. (2006). Environmental principles applicable to supply chains design and operation. *Journal of Cleaner Production*, *14*(18), 1593-1602.

Twede, D., & Clarke, R. (2004). Supply chain issues in reusable packaging. *Journal of Marketing Channels*, *12*(1), 7-26.

Volvo Cars. (2017a). Our Company at a Glance. Available at: <http://www.volvocars.com/intl/about/our-company/our-company-at-a-glance> [Accessed: 170407].

Volvo Cars (2017b). *Volvo in Brief*. Available at: <http://www.volvocars.com/se/om-volvo/foretaget/om-volvo-cars> [Accessed:170205].

Volvo Cars. (2016a). *Volvo Cars Packaging Catalogue*. Unpublished internal document (PDF). Volvo Cars.

Volvo Cars, (2016b). *Container Selection Process, Global Buyer Requirements & Supplier Guideline.* Unpublished internal document (PDF). Volvo Cars.

Volvo Cars Packaging Operations, (2017). Unpublished/Confidential Documents and Data.

Wild, T. (2002). *Best Practice in Inventory Management, Taylor and Francis*. Jordan Hill. Available at: <http://ebookcentral.proquest.com.ezproxy.ub.gu.se/lib/gu/reader.action?docID=297114> [Accessed: 170502]

Zsidisin, G.A.A. et al. (2015). Examining supply market scanning and internal communication climate as facilitators of supply chain integration. *Supply Chain Management*, 20(5), pp.549–560.

Zhang, Q. et al. (2015). Returnable packaging management in automotive parts logistics: Dedicated mode and shared mode. *International Journal of Production Economics*, 168, p.234.

Zhou, Naim & Disney. (2017). The impact of product returns and remanufacturing uncertainties on the dynamic performance of a multi-echelon closed-loop supply chain. *International Journal of Production Economics*, 183, pp.487–502.

Appendix 1

Below follows a description of the number of packaging per type that is required for assembly of each Volvo Cars model (Volvo Cars Packaging Operations, 2017).

	#EMB1	#EMB400	#EMB780
V60	**4,821**	**0,330**	**5,338**
V60 - CC	**4,631**	**0,293**	**5,155**
S90	**5,794**	**0,461**	**4,905**
V90	**5,933**	**0,482**	**4,157**
V90-CC	**5,880**	**0,440**	**3,889**
XC60 - TorslandaNew	**7,026**	**0,529**	**4,826**
XC90	**7,217**	**0,691**	**4,890**
S60	**3,799**	**0,212**	**5,479**
S60-CROSSCOUNTRY	**4,051**	**0,279**	**5,924**
V60	**3,782**	**0,302**	**4,775**
XC60 - GhentOld	**4,411**	**0,405**	**6,204**
V60-CC	**4,209**	**0,307**	**5,600**
V40	**3,649**	**0,342**	**3,866**
V40-CROSSCOUNTRY	**3,732**	**0,348**	**3,991**

Appendix 2

The tables in this appendix present the measurements of the packaging types used for this thesis. (Volvo Cars Packaging Operations, 2017)

Pallet of Wood, type L – #1

Measurements per unit				
Length in mm	Width in mm	Height in mm	Volume in m3	Net Weight in kg
1225	820	151	0,15	25
Measurements per bundle				
Units per Bundle				
10				
Length in mm	Width in mm	Height in mm	Volume in m3	Weight in kg
1225	940	1075	1,24	250

Combitainer - #400

Measurements per unit				
Length in mm	Width in mm	Height in mm	Volume in m3	Net Weight in kg
1640	1235	1366	2,77	123
Measurements per bundle				
Units per Bundle				
1				
Length in mm	Width in mm	Height in mm	Volume in m3	Weight in kg
1640	1235	312	0,63	123

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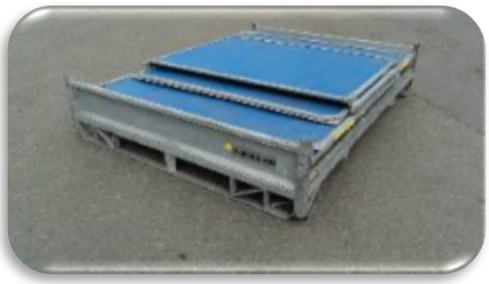

Plastic Box - #780

Measurements per unit				
Length in mm	Width in mm	Height in mm	Volume in m3	Net Weight in kg
600	400	200	0,05	2,8
Measurements per bundle				
Units per Bundle				
40				
Length in mm	Width in mm	Height in mm	Volume in m3	Weight in kg
1225	835	920	0,94	146,6

Appendix 3

This is the material that was used for the group discussion.

Group Discussion

Purpose: The purpose of the is to get a glimpse of the internal communication and overall thoughts of the current situation and unbalanced loop-time that the Volvo Cars Packaging Operations are facing, by listening to the thoughts and opinions that the different groups in the organization have about the problem that and they are affected by it. How is it believed that the problem may be affected and improved? Our perspective of the problem as thesis authors is limited since we do not work with it daily and therefore we believe that a group discussion can give us a better insight into the situation.

Method: One of the theories mentioned in the theoretical framework will be used as the base to this group discussion, namely the PZB ServQual model, which discusses five different dimensions and analyzes potential gaps that may exist internally and externally in a company or organization. This is an open discussion where supplementary questions certainly are allowed. The discussion will be recorded; however, no names are needed to be mentioned, which is why this discussion will remain anonymous (possibly working teams will be mentioned to facilitate). If we believe that additional answers are needed, we would appreciate if further e-mail contact would be in order.

Questions

1. Spontaneously, what do you believe is the main reason why the loop-time is unbalanced today?
2. What are the main gaps you see in the process? Where in the process do you think it's the most critical?
3. How does each team suffer from an unbalanced loop-time? Is it different depending on the team?
4. The theory mentioned in the thesis with discusses much about the importance of working with internal communication to lay a good foundation in an organization. Do you believe that the internal communication you have today can affect the loop-time and improve it?
5. How consistent is the workflow and how reliable is it? Both internally and externally. How do you experience it from the suppliers?
6. Do communication difficulties exist and do they tend lead to misunderstandings?

7. Do you consider that the level of competence differs depending on the supplier and how do you handle such a situation?
8. Does it occur that the internal communication is inadequate to the point where it affects the performance of the suppliers?
9. Where does the supplier performance lack the most, according to you?
10. How well does feedback and evaluation work back from supplier?
11. Describe the dream scenario. How would you like it to look like? Please develop.