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Proposal for efficient logistics system within the global direct delivery systems at Volvo Cars

Master of Science thesis at Supply Chain Management, Chalmers University of Technology

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ABSTRACT
Volvo Cars Customer Service (VCCS) is a unit within Volvo Cars Corporation, responsible for handling all spare parts and accessories to the aftermarket. They use a direct delivery channel, Direct Delivery Global System (DDGS), for a range of products. Painted bumpers are considered a DDGS product and are produced by Plastal and shipped directly to the car dealers without intermediaries. VCCS experienced complaints from dealers regarding the lead-time from order to delivery and the aim of this study is to illustrate the current flow of bumpers, making an analysis of the lead-times to different sales markets and to suggest improvements in the cooperation between Plastal and VCCS.

To propose some suggestions in accordance with the aim of the study, it was necessary to understand the flow of bumpers, from production at supplier until received at dealers. By making interviews and observations with actors from Plastal, VCCS and dealers, it was possible to understand of the different activities and processes connected to the flow of bumpers.

Ten problems connected to either IT/System or Organization and Management was identified. We discovered a link between the problems of which one problem created synergies that resulted in additional problems. Therefore, the issues all related to the overall performance of the supplier.

Three main solutions were identified in order to improve the supply chain efficiency and enable a smooth and transparent DDGS flow of bumpers. Firstly, increased number of measuring points is essential to determine the exact lead-time and avoiding time-consuming lead-time calculations. Secondly, enable the dealers to receive the bumpers when they need they actually need the products. Lastly, involving a cross-functional core team whose aim should be to assist the supplier with production issues and coordinating the flow to increase the customer value.

Keywords: Supply Chain Management, Cross-functional teams, Supplier-Buyer relationship, Material Planning and Control,

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Robin Andrén, Peter Novakovic

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1. Introduction

The following section will introduce the reader to the background of the problem for the principals, giving an insight in the currently used market channels and presenting the channel in focus and the reason for this. The chapter continues with an introduction of the principal and the focus supplier within the concept of direct delivery. Moreover, a presentation of the purpose, the scope of the project and most important the research questions are described.

1.1 Background

Volvo Cars Customer Services, VCCS, is a unit within Volvo Cars Corporation in the department of material supply, responsible for handling all spare parts and accessories for the aftermarket for all produced cars made by Volvo Cars. VCCS policy is to provide spare parts for a specific car model, up to 15 years after final date of production.

VCCS uses different market channels to reach out to their customers. They have one Central Distribution Centre, CDC, in Torslanda, Gothenburg, were they store close to all possible spare parts. Further they have a number of National Distribution Centres, NDC, placed in North America, Asia and Australia. Furthermore, Volvo possesses SDC's in some market around Europe as well as they have Local Distribution Centres; LDC placed closer to the customer, with a smaller assortment then the other distribution centres. The warehouse structure can be seen in figure 1.

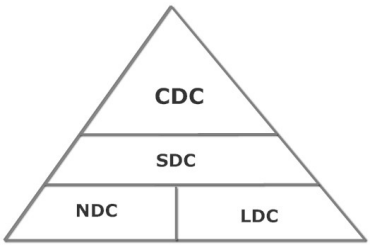

Figure 1: Warehouse structure

If a product is missing at the LDC, an order is sent from the closest distribution centre one level above in the hierarchy. For some range of articles another channel is used; the Direct Deliver Global Supply, DDGS, which enables the product to go directly from the supplier without any intermediaries to the customer, reducing inventory and handling cost due to the size of each individual article and the number of variants per product.

One of the spare parts handled in the DDGS concept are bumpers. The supplier responsible for the bumpers is the company Plastal, head office in Arendal, Gothenburg. When VCCS gets an order from a customer about bumpers, an order is sent through the ERP system to the supplier. Plastal are then responsible for completing and ship the order to customer, through a predefined 3PL, within a lead-time of maximum six days. The 3PL transports the goods from the Plastal plant in Raufoss, Norway, and cross-dock the distribution centre in Torslanda to consolidate the transports to the customers.

The DDGS concept is not connected to VCCS main computer system to the same extent as other product groups, which normally enables VCCS to follow the product from supplier to customer and to be able to report any unexpected delays or quality defection. Today, VCCS gets phone calls from dealers about the delivery precision that's exceeded the agreement. Due to the lack of connection between the computer systems, VCCS don't know how long the total average delivery lead-time is or how the processes in the supply chain look like. In cases where the delivery precision is not met it often implies increased cost for Volvo Cars.

In discussions with VCCS the writers have identified some problem areas; firstly there are complaints from resellers regarding the promised delivery lead-time from order to received

order. Secondly the insight into the own flow is insufficient. They are not sure about the total transport time to different markets and they cannot follow a customer order because the bumper flow is not connected to the VCCS main computer system. Thirdly, Plastal has substantial number of back order queues partially due to large order queues and large amount of incoming orders. Therefor VVCS would like to find improvement areas for making Plastal a better DDGS supplier.

In order to increase the efficiency of the organisation VCCS want to get an overview of the DDGS flow of bumpers from Plastal. Moreover, they wish to improve and increase the insight in the processes in order to yield accurate information about the orders to the customers, both for themselves and their suppliers.

1.2 Scope

The purpose with the project is to provide a material flow mapping of the current situation for the bumper flow within the DDGS-concept and make an analysis of the lead-times to different sales markets. Further a proposal to an improved logistics arrangement will be done; including an overview of the cross docking arrangement in Torslanda, suggestions for monitoring of Plastal's delivery performance and a proposal of KPI:s for future use.

1.3 Research Questions

In order to meet the scope in a satisfying way there are a number of in depth topics that needs to be investigated further. The writers have divided the thesis into three main questions of where each and one has underlying issues, which will help to answer its main question, respectively.

RQ1: How do the current situation and setup of the DDGS bumper flow look like?

- How is the flow controlled and monitored today?
- What strength and weaknesses has been recognized within the current logistic setup?

RQ2: What issues have to be solved in order to make the lead-time for the DDGS bumper flow to the customers more precise?

- What is the current lead-time to markets?
- Which KPI:s are used to measure lead-time to dealer today?
- Which KPI:s can be used to improve the measurement of the lead-time in the future?
- Which functions in the organizations are responsible for deciding the lead-time?

RQ3: What issues in the supply chain have to be solved in order to improve the cooperation between Plastal and VCCS?

- Are there any areas of the current situation that relates to theory?
- What problems can be identified in the current situation?
- How can the problems be solved or mitigated to improve the overall performance?

1.4 Limitation

The report will not treat Plastal's plants in Gent, Simrishamn and Gothenburg, but some of these plants will be mentioned during the thesis in order to increase the understanding. The sales markets included in the report will cover Sweden and northern Germany.

The DDGS bumper flow for European (Maastricht) and overseas customers are important to discuss in order to understand the total flow of bumpers, but also to get a deeper knowledge about problems that has been identified during the thesis.

2. Methodology

The following chapter will present the thesis process to the reader aiming to present the steps carried out during the project as well as present information of the methods used. Starting with presenting the structure of the investigation, followed by a presentation of the research questions, which is central in the thesis work. This is then leading the reader into a discussion of the intended sources for the thesis and a discussion of the data that will be collected and finally the chapter is concluded with a discussion on how to ensure the validity of the sources.

The purpose with research of this kind is to spread knowledge to the community through education, but more importantly by implementing changes. The knowledge gained through research and investigations, among others, acts at decision support. Sachdeva (2009) claims that the purpose with research is to increase the understanding of the phenomenon of interest through the systematic process of collecting and analysing data. As research and investigations seeks to produce knowledge, Patel & Davidson (2011) claim that the difference between those two is the relationship to theory. While research is theoretically grounded, meaning that the work has its starting point in theories and models, the authors states that an investigation on the other hand doesn't require a theoretical ground; meaning that the problem area is not required to described in terms of theory and models. However, Patel & Davidson (2011) states that investigations can or should ignore knowledge in the addressed area.

This master thesis is addressed mainly as an explorative investigation, where Patel & Davidson (2011) describes that the purpose of this type of investigation is to gather all available knowledge and to illustrate the problem area in a comprehensive way. Important aspects with this kind of work are resourcefulness and creativity. Sachdeva (2009) argues that exploration research is useful when researchers want to develop concepts more clearly. However, the investigation is not exclusively explorative. Rather it should be seen as a hybrid between descriptive and explorative with the majority proportion to explorative. A descriptive investigation is, according to Patel & Davidson (2011), an investigation with the purpose to describe conditions in the past and circumstances that exist at the moment while the boundaries are to examine a limited amount of aspects of a certain phenomenon. However, Jonker & Pennink (2009) argues that the research and its methodology specifies ways of acting in different situations but do not set the exact way of reaching to the targeted goal.

In science, one distinguishes between empirical and non-empirical sciences. Patel & Davidson (2011) interprets empirical science to experience and describes knowledge gained from empirical science as knowledge obtained from reality observations. Further, an inductive-working scientist is said to study the object without anchor the investigation into existing theory. Instead with the gathered information of the object, empirical, the scientist formulates a

theory. However, an investigation is not said to fit completely into a deductive or inductive way of work since an investigators objective isn't to produce knowledge as theories (Patel & Davidson, 2011). The authors claim that investigators applying theories that fit the actual problem or draws conclusions about individual phenomena without phrase themselves theoretical.

There are two empirical research approaches that correlates to the thesis; Grounded theory and Phenomenography. These belong to the qualitative approaches that Patel & Davidson (2011) translates as science that seek something behind the immediate sighting. The authors describe grounded theory as the reverse objective to construct theoretical superstructures; you form a local theory with primary coverage for the unique case based on empirical evidence. Phenomenography on the other hand is similar to grounded theory, but aims to study views. Common practice is that the scientist usually works with open interviews where the interviewee should describe his conception of a phenomenon in his own words. This is said to be an inductive process, where the scientist read and sorts the material until patterns can be found. Patel & Davidson (2011) states that Phenomenography doesn't aim to find theories into final regularities since it is based on human conceptions.

2.1 Thesis structure

Patel & Davidson (2011) claims that there are two kinds of research, of which these aim to describe how the investigators choose to generate, process and how to analyse the gathered information. One can see these as two endpoints in a continuum, but the majority of the research that is done today is to be found in the space in between those endpoints (Patel & Davidson, 2011).

In quantitative research the purpose is to conduct research with bearing to measurements at data collection, statistical processing and analysis methods, while the translation of qualitative research is research where the data collection is based on soft data meaning qualitative interviews and interpretive analysis methods. Hence, the investigation in this report has its roots in the qualitative endpoint. The data collection consists of interviews, field studies, and data gathered from the host company and its relevant actors in their supply chain. The study will be supported by literature, which will introduce relevant academic theory.

The thesis is divided into five phases; the first part in the study is the steps of define and forge the problem, section one. This will lead to a bundle of questions that will support the scope of the research. Through these questions a comprehensive study including interviews and field studies (described in section 1.2 and 1.3), will form which aims to plot the project and lead

Figure 2: Thesis structure

down to the last two phases; the analysis and the conclusion. The structure is presented schematically in figure 2.

Research questions

In order to be able to map the physical flow of the bumpers from the main supplier to the host company, describe how the lead-time can be more precise and how the cooperation between Plastal and VCCS can be improved, a number of research questions are developed. The purpose of this is to enable directed literature search and constitute a base from which interviews and field studies can be held to yield relevant information. These questions correspond to the main purpose of the thesis and aims to split the objective into smaller parts wherein each part can be seen as a milestone of the project. The questions will also contribute in the sense of being a navigation tool for the investigators.

Literature study

The study is not based entirely on academic theory but it is necessary to introduce pertinent theory in the supply chain field, in order to generate an analysis and conclusion, which has bearing to academy and result in a conclusion that can generate benefit to the host company. The literature study will be of a qualitative character and the search will be performed consultation, manual search and computer-based search. The consultation method is when experts give advice of relevant literature while manual search is the method of using reference lists, book references, and research overview to find relevant information (Backman, 2008). Computer-based search is according to Backman (2008) used to systematic find information in a both time- and economic effective way.

2.2 Data collection

It is essential to gather information in order to answering the research questions and finally end up in an analysis and conclusion with satisfactory result, which has bearing both in academia and at the host company. The data in this master thesis will be collected from a number of sources which consist of interviews, field studies as well as data regards sales statistics, delivery precision and relevant data connected to the upstream and downstream of the host company's supply chain.

Interviews

The purpose with the interview is to find relevant information that describes the problem from different angles depending of the interviewed person. The interview will be of significant value for the study.

According to Kvale (1996), interviews often secure data that are not available elsewhere. There are two categories of interviews, structured and unstructured, where the initial one has similarities of a questionnaire (pre-made questions with minor room for desired response deviation) and the latter interview form is of a more informal character and uses a few general questions and allows the interviewer to penetrate into further discussions regarding the chosen subject (Philips & Stawarski, 2008). In this master thesis the named forms of interviews will be used to a certain degree, where the unstructured form will be the most common.

Bell (2000) states that a great advantage with interviews is the flexibility they provide and give answer that written answers may not give. The interviewed persons will be chosen with consultation of the supervisor at the host company as well as the Master Thesis supervisor from Chalmers. The target is to interview persons that can provide information in their field of expertise, information that can be used to describe the holistic perspective of the problem.

The questions used during the interviews have been adjusted depending on the interview object and thus follow a low degree of standardization (Olsson & Sörensen, 2001). Meaning that the interviews have been of qualitative character and that the interviewees have obtained the opportunity to respond with their own words (Patel & Davidson, 2011).

The interviews in this thesis have been made with people from different parts of the supply chain. Production planners and workers at Plastal in Raufoss, people responsible for the bumper flow at Volvo Parts Sweden (who communicate with the dealers), persons that had important or necessary knowledge about the bumper flow within VCCS, truck drivers from transport company LRN, people working at the LDC's and finally site managers and dealers who receive the bumpers. The interviewed person, their position, where they work can be seen in Appendix A.

Field studies

In the progress of the investigation a number of field studies has been conducted with the aim of adding information, which can give information that help answering the research questions. The objects for the studies are chosen out of the requirements that they are highly involved in the flow of the bumpers and in consultation with the supervisors. The Plastal plant in Raufoss, Norway, which is one major part in the supply chain of bumpers, will be one object to study in detail.

The structure of the field study in Plastal Raufoss is organized as structured observations with preparation in forehand, in order to find information that only is relevant to the thesis. Other objects to study further is the logistic provider LRN based in Gothenburg, the LDC-concept in Gothenburg, as well as the resellers to Volvo Cars based in the area of Gothenburg, Bra Bil in Stig Center and Bilia in Almedal.

The structure of these studies will be of an informal character, an unstructured observation with the purpose to gather as much information as possible about their role in the chain (Patel & Davidson, 2011).

During the field studies another type of collection method will be used called observation. The method is used to gather data about observed participants and recording changes in their behaviour (Philips & Stawarski, 2008) as well as observing flows and work processes.

When dealing with the analysis of the data there are either quantitative methods or qualitative, meaning non-numerical, methods. The collection of data for the project will consist primarily of a qualitative perspective and partially by quantitative point of view; this depends on the degree of relevant data that are provided from the earlier named actors of the chain.

2.3 Quality reflection

Substantial amounts of the project will be based on interviews with the different actors in the supply chain. It is valuable to find data that can validate the interviewed person's point of view or to critically review the possessed. The likelihood that a interviewed person is coloured by its own organizations point of view is considerable and the search for data that prove the thoughts is essential. In that case numeric data could not be found in order to prove a statement, the statement must be compared to thoughts of other actors in the supply chain (i.e. comparing reseller's point of view with the view of the host company).

The project is as well based on literature from academia and there is a risk that the information retrieved is biased by the author's opinions. Bell (2000) consider that it is important to question whether the arguments presented support the author's views and conclusions. The focus when searching for literature is therefore to find positive petitions as well as critical reviews. In order to develop a thesis work with high trustworthiness, the on-going data collection continuously need to be critically reviewed and compared to other sources of data. When applying theory into an analysis one have to remember that it is difficult to take one theory and implement the ideas into your organization without any difficulties. The theories should be used as guidance of how you can use the ideas of the particular theory and create your own perception based on the theory.

For the field studies the objects in focus may be giving an image of the processes, which is not equal to the situation on normal conditions in a factory or a shop. Companies would most likely mainly present successful processes and may be wary to admit failures. With this in remembrance, the writers need to be well prepared for the field studies when it comes to figures and be critical in their review in order to secure the validity of the field visit.

Since the two qualitative approaches described in the beginning of the chapter; Grounded theory and Phenomenography, is inductive and those don't base in existing theory, the aim is instead to build a reliable local theory applicable to a unique case. One can criticize the approaches to not reach sufficient depth and instead only describes surface phenomena. According to Patel & Davidson (2011) criticism has been raised that these approaches are subjective and not interesting due to the local connection and the description of surface phenomena. However, the role of a scientist or investigator must be to act objective regardless of the employers' intention.

3. Theoretical Framework

The following chapter presents the theory correlating to the inductive investigation of the DDGS flow of bumpers. The theory collected in the chapter refers to the object in focus in terms of what the authors found as possible improvement areas. Further, it refers to the research questions of the thesis and shall act as base in the analysis and future recommendations.

The section is divided into four categories, which all should give enough information to understand the activities and the processes of the flow. First there is a section discussing the Kraljic portfolio model, which is a model seen as a tool for analysis in order to categorize a company's suppliers and supplies since different suppliers and different supplies has diverse interests of a company.

The second section is explaining importance aspects of the Toyota philosophy. It is important to understand that the information presented in this section is extract from the Toyota Philosophy. The complete philosophy is described in an extensive way and contains parts that is not referring to the investigation and has therefore not been of interest for the thesis. It may seem simple to extract some parts but it shall be mentioned that Volvo Cars has been working with a lean transformation for a time and therefore the section of the extractions of the philosophy is relevant.

The third category addressing the area of cross functional teams which is a way of combining people from different functions into one working group in order to gain efficiency in the supply chain processes.

Lastly, the fourth section dealing with performance measurement. It has been central in the discussions with the host company to deal with measurements in the future and is addressed in the research questions.

3.1 Kraljic Portfolio Model

Peter Kraljic wrote the article *Purchasing must become supply management* who was published in Harvard Business Review 1983. His theories regarding the importance of purchasing and the creation of portfolio models are still used today. In the article, Kraljic present a model known as the Kraljic portfolio, which is seen as a tool for analysis in order to categorize a company's suppliers and supplies. The analysis bottom line is that suppliers represent different interests for a company.

Arjan van Weele (2005) emphasize the importance of developing differentiated strategies towards the supply market and underlines a key element when designing a commodity strategy as the issue of influencing the balance of power between the company and its suppliers. Van Weele interprets that the power balance should be in favour for the buyer otherwise the supplier could take advantage of the situation and use it in their favour.

The same author states that an initial step needs to be carried out before using the matrix, the company is required to make an analysis of the purchasing spend per category and its supplier base in order to identify the company's strategic commodities and suppliers. Using the Kraljic portfolio can now refine the analysis.

The portfolio model

Kraljic (1983) writes that there must be a shift in perspective, from an earlier focus in purchasing as an operating function to a strategic function as supply management. At a reasonable cost level a company want to secure long-term availability of material and components that are critical. With an increasing degree of global sourcing, companies must learn to handle risks, supply and price disruptions. The article suggests a strategy for managers to guard themselves from these disruptions and to secure supply.

Kraljic (1983) describes two factors that set the importance of a particular supply strategy. The first factor is to determine what is the strategic importance of purchasing (i.e. the percentage of raw materials in total costs and their impact on profitability) and the second factor describing the complexity of the supply market in terms of entry barriers, logistics complexity and costs, supply scarcity and so on. Through assessing the company's situation in terms of these variables, Kraljic claims that management can determine the type of supply strategy and to minimize the risks in the supply of goods. This assessment will question the current processes and investigate questions like; how much risk is acceptable? Can the company avoid anticipated supply bottlenecks and interruptions?

An approach, which has been used by several European companies, is a four-stage approach to set a strategy. Kraljic (1983) states that to following this approach, the companies start by classifying its purchased goods in terms of profit impact and its supply risk. This is followed by an analysis of the supply market for the chosen goods. The third stage is to determine the overall strategic supply position and the fourth step is to develop material strategy and an action plan. This type of approach gives the management an effective framework for classifying procured items and is assisting when forecasting future supply scenarios. The definition of the stages is presented in the next section.

Phase 1: Classification

In this phase you should analyse the procured items and classify them into four categories; Strategic (high profit impact, high supply risk), Bottleneck (low profit impact, high supply risk), Leverage (high profit impact, low supply risk), and noncritical (low profit impact, low supply risk). This is shown in figure 3. The Y-axis (from low to high) shows the importance of purchasing (profit impact) of a given procured item, i.e. volume purchased, percentage of total purchase cost and so on. On the horizontal axis (x-axis) the supply risk is (complexity of supply market) defined, this in term of availability, number of suppliers, competitive demand, make-or-buy opportunities etc. As time goes these classifications may need to be modified and the purchasing classification requires regular update.

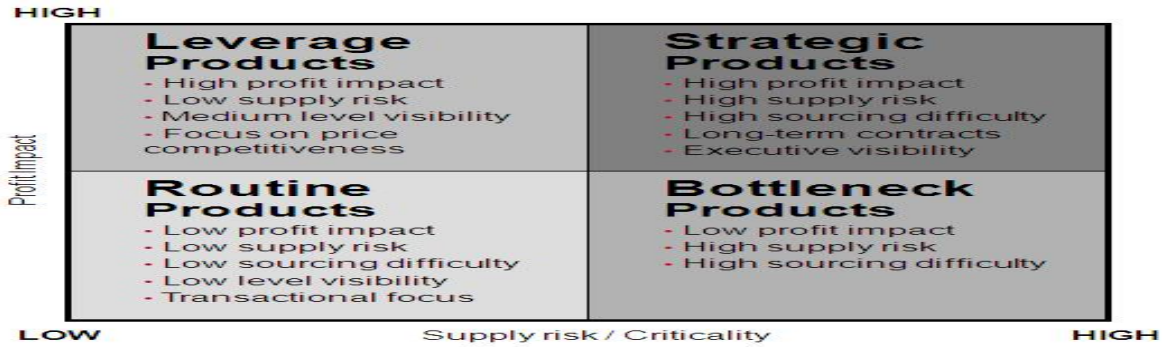

Figure 3: Kraljic Segmentation model (artzblog.com, Access 2013-11-27)

Phase 2: market analysis

The second phase questions the bargaining power of its suppliers against its strength as a customer. Some examples of the suppliers and company strengths to weighting are; suppliers' capacity utilization, suppliers' break-even stability, uniqueness of supplier's product, annual volume purchased and expected growth in demand, potential cost for non-delivery etc.

Phase 3: strategic positioning

The company shall position the items classed as strategic, from phase 1, in the purchasing matrix figure 4. This diagram plots how a company buying strength against the strength of the supply market. With this diagram the company can identify areas of opportunity or vulnerability, assess supply risks, and derive basic strategic thrusts for these items.

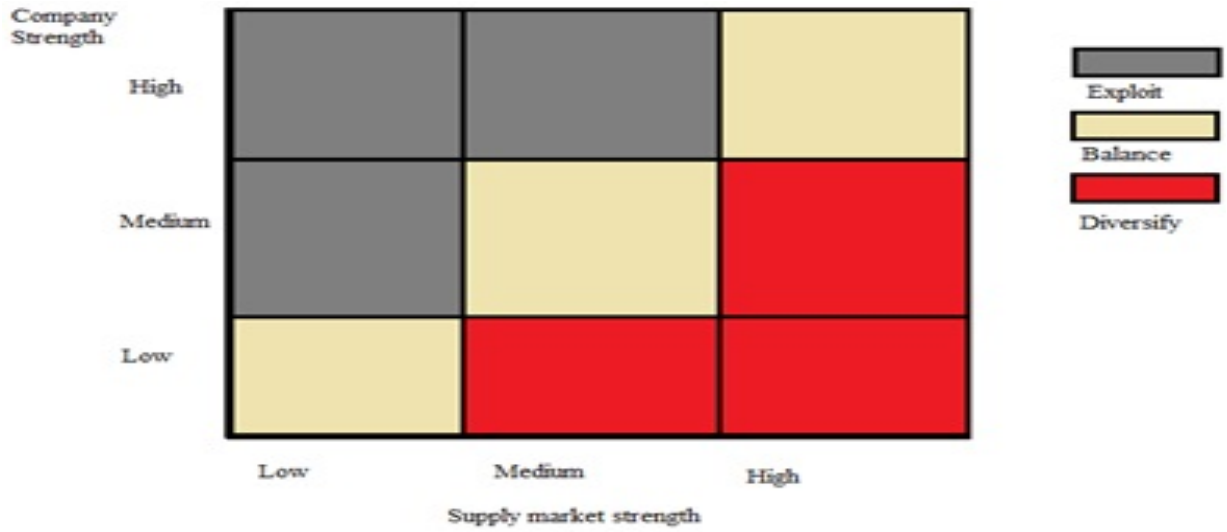

Figure 4 Purchasing portfolio matrix illustration

Phase 4: action plan

The product in this phase will be range of documented strategies for purchasing of critical materials that specifies the timing of and criteria's for future action. Hence, one should explore a scope of supply scenarios in which it lays out its options for securing long-term supply or for exploiting short-term opportunities; clearly define respective risks, costs, returns, and strategic implications; and develop a preferred option with objectives, steps, responsibilities, and contingency measures laid out in detail for top management approval and implementation (Kraljic, 1983).

As a conclusion to the method, this analysis give guidance to what supply strategy a company could use regarding different sets of products or suppliers. However, Van Weele (2005) points out that one have to consider another aspect that can hinder the opportunities of the approach. A strategic product for the buyer does not imply that the same product is of strategic relevance to the supplier involved. One has to find a proper fit for the product between the supplier's customer portfolio and the buyer's portfolio. A good fit between these portfolios stimulate the possibilities for an effective future collaboration between the buyer and the seller. This has led to the development of the Dutch Windmill approach, which is used in combination to the portfolio by Kraljic.

Van Weele (2005) describes this approach as a combination of the buyer's portfolio to the supplier's customer portfolio, which leads to 16 different business-to-business relationships where each relationship requires a different sourcing strategy. The portfolio and the Dutch Windmill combined will lead to more effective supplier/buyer collaboration in terms of expectations in the future. A representation of the Dutch Windmill is seen in figure 5.

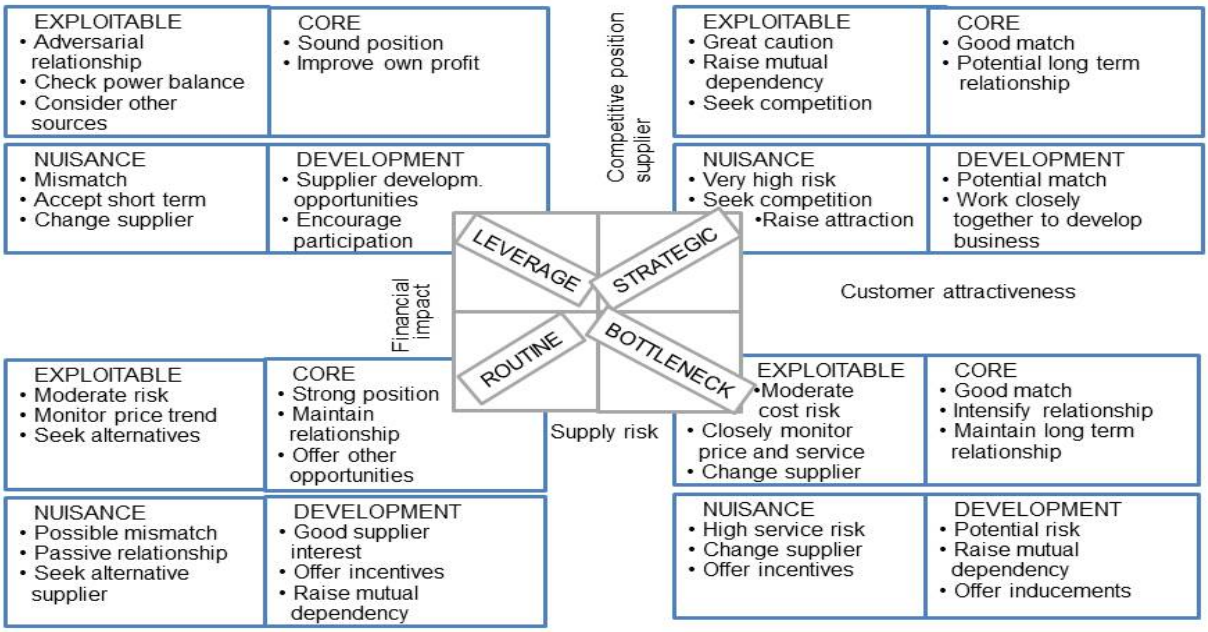

Figure 5: The Dutch Windmill (Van Weele, 2005, *Purchasing and supply chain management (5th edition)*, pp. 202)

3.2 Toyota Production System

Due to the economic situation in Japan after the World War II, when the resources where minor since the military industry underwent downgrading, the civil industry had to compensate for this. This was starting point for Toyota Production System, TPS, which can be explained as a philosophy of resource efficient production. A common expression that describes the philosophy is *more value for less work*.

Toyota has been developing their philosophy since the start, creating an efficient production system, but it wasn't until 1990 when James Womack described their concept in the article "The machine that changed the world" and coined the term *Lean Manufacturing* that the concept had its international breakthrough. The concept has had an increasing interest globally, especially in academia, since and the lot of research has been done in the field. With time Lean Manufacturing has developed into the term Lean Production that is seen as, more or less, synonymous to TPS.

The scientist Jeffery K. Liker has put a lot of time and effort into understanding TPS and has written several books in the field trying to explain the philosophy. In connection to this several organizations, especially in automotive industry, has been developing their own production systems in order to streamline their processes. Through Likers research he identified 14 principles, which he sees as the key principles that drive the techniques and tools of Toyota (2004). These principle has he divided into four sections; Long-term philosophy, the right process will produce the right results, add value to the organizations by developing your people and partners and lastly continuously solving root problems.

However, Liker clearly states that understanding TPS does not automatically make a company successful; TPS should rather provide inspiration to companies wanting to be a learning enterprise. Further, TPS examination provides a way of thinking that challenge the organization and can be applied both in companies progressing into a Lean transformation as well as those who not.

The following describes some of the 14 principles that correspond to the processes of the supply chain.

Principle 2: Create continuous process flow to bring problems to the surface

TPS is constantly seeking a one-piece-flow by eliminating non-value adding efforts to their products while in contrast traditional business processes hide inefficiencies in their processes, for instance by keeping large inventories. Liker (2004) describes this behaviour in the following sense: lowering the water level of your inventory will expose the problems but creating a flow will lower the water level and the inefficiencies will be exposed and do require a direct solution.

In Likers research he identified that Toyota constantly seek to eliminate eight non-value-adding activities in their processes in order to progress into one-piece-flow. These are:

- Overproduction
- Waiting
- Unnecessary transport
- Over processing
- Excess inventory
- Unnecessary movement
- Defects
- Unused employee creativity

The ideal flow would be that the customer order should trigger the supplier to obtain and process the raw material. This will instantly flow to the suppliers who complete their activities and transport to the plant of origin. According to Liker (2004), the time for finishing and completing the order shall take a few hours or days. Through the authors observations this is not reality but shall be seen as a target to strive towards. The view in TPS is a company should rather keep the material moving through the processes by using small batches and locating the workstations close than produce excess inventory that will be waiting for usage.

Lean differentiates itself to traditional mass production by arranging production and its equipment into a one-piece-flow with work cells grouped by product while traditional mass production arrange its production in process cells (equipment with the same function is grouped in the same area). The difference is according to Liker (2004) that traditional mass production seeks economies of scale by utilizing its equipment to 100% to generate small capital cost per piece, which will create substantial buffer inventories while TPS focus on having the fastest possible throughput time through the factory. The results in the TPS case would be that one can create a flow that eliminates inventory and overproduction by line the processes in the sequence that produce the customer's orders is the shortest time.

The principles described above roots in creating a flow that achieve only value adding activities in a continuous sequence. The key is continuous improvement process within the organization and trying to make the flow visible to the organization.

Principle 4: Level out the workload (*Heijunka*)

Liker (2004) states that "the right process will produce the right results" and that this can be achieved by levelling out the workload, Heijunka. As the interest for Lean Production grows companies implementing their own production systems based on TPS and a common staring

point is according to Liker (2004) by eliminating waste, Muda, in TPS. Muda is a notion containing eight different activities, which is seen as wasteful. These activities do not add value to the end customer and can be excess inventory, unnecessary transportation, over-production etc. Liker states that exclusively focusing on Muda could lead to productivity of a company's people and the production system.

Muda is one of three cornerstones of the waste reduction system in TPS. The other two types of variations are Muri and Mura. In order to make lean production to work all the cornerstones are equally important. Muri is the waste of overburdening of people and equipment where Mura is translated from Japanese to unevenness.

The three M's all collaborate with each other. According to Liker (2004), companies often fail in creating a stable system, an even flow of work, which is the concept of Heijunka. Creating an even flow of work, levelling the work schedule, is essential in eliminating Mura, which in turn is elementary in order to eliminate Muri and Muda.

With a levelled schedule one will be able to increase the overall customer satisfaction since it will be possible to accumulate incoming orders, which can result in shorter standard lead time to customer (Liker, 2004). In normal conditions in companies who practice make-to-order, systems orders come unregularly and as a result there will be times with high work load for the production and times where the opposite occur.

Levelling production and schedules through Heijunka

In satisfying conditions one would like to produce parts according to the actual customer order with a through one piece flow. However, customer orders come unregularly with the demand that swings from high to low demand constantly. To manufacture to actual customer demand a company has to produce products irregularly (Liker, 2004). If one can accumulate orders for a specified limited time frame and determine the pattern of the volumes and product mix one can plan a stable production schedule every day without major peaks or low utilization of the equipment and personnel. There will be smaller batch sizes, a levelled and mixed-model production. This is called *Heijunka* -levelling of production of both volume and product mix.

By balancing the production, four benefits can be achieved (Liker, 2004):

- The customer doesn't buy products in a predictable pattern. When a customer orders unexpected large number of a product, the production schedule must be arranged to manage these peaks. One can manage these peaks by holding a major finished goods inventory of the product range, which leads to high inventory cost and requires a large storage area. The first benefit of a levelled schedule is the flexibility it provides by producing what the customer wants when they want it, and in turn reduces the inventory required with the traditional setup.
- If a plant producing products that are experiencing an unexpected low customer demand, the company running a risk of stocking unsold goods. If the production schedule meeting the customer demands, the plant doesn't need a finished goods inventory that is eating costs.
- In a production plant, the labor requirements oscillate over time. Thus, some products require extensive labor requirements, while some products are simple to produce and can be managed by only a smaller amount of manpower. The resource usage inside the plant is therefore unbalanced and it is likely to find Muda and Mura in the processes. If

one can consider the requirements in terms of labor differences in the production, knowing that some products require extensive work while others don't, it is possible to create a levelled production scheme that is balanced in terms of the use of labor and machines over the day.

- In a traditional view, a plant is setting its schedule on i.e. weekly basis. Most likely the plant will prepare its suppliers to deliver goods according to this schedule but when there are shifts due to rush orders of a product the schedule will need to be changed and the plant will require its suppliers to deliver goods needed for that production process earlier than first agreed. The customers soon realize this and need to keep inventory. In case this occur, in order to secure demand, the supplier suppliers will soon act the same and keep even bigger inventory in order for them to secure demand. Throughout the supply chain there will soon be large inventories in several tiers, which do not add value and instead ties up capital. This is called the "bullwhip effect", which describes the behaviour of multiplying backward the supply chain, small changes in the customer tier will multiply backwards the chain creating great variations with high inventories in the opposite of the customer tier of the supply chain. With the levelled schedule on the other hand, together with just in time system in the upstream processes, the suppliers can deliver multiple times a day and instead get a steady set of orders the suppliers can reduce their inventory, and thus bring down their tied capital.

Heijunka allows the production plant to produce parts with flexibility corresponding to the customer demand. However, it seems logical to produce a particular product for a longer time in order to gain economies of scale and to decrease the changeover times. The changeover times are often a problem in production plants because it requires extensive time, especially when producing complex products, it is not possible to use the equipment for producing during the changeover.

Liker (2004) argues that none of the benefits mentioned above would be possible if there is an extensively decrease in the changeover time, where a changeover time of zero would be the utopia. Consequently, making a thorough analysis in how the changeover is done at the moment and a proposal to how it shall be done in the future is essential. For instance there will be processes that could be done while the equipment is still running and the probability to find wasteful processes are significant. If ignoring the changeover time a production plant can build products on a mixed-model assembly line and can satisfactory match the customer orders with production schedule.

Principle 5: Build a culture of stopping to fix problems, to get quality right the first time.

Liker (2004) mentions that preventing problems as they appear is highly more effective as well as less costly than traditional mass production where controlling, inspecting and repairing of quality errors often occur in the end of the production line. In this there would be a work in progress on several products that may experience the same problems that can be found with deficient quality.

With the low levels of inventory in a Lean environment, the importance of building error less products at the first time is necessary, due to that fact that there are no inventory buffers between stations. With *eliminate waste* thinking in mind; a company should fix the problems at the source as they occur and this will save both time and money (Liker, 2004).

To summarize this principle, the inherent philosophy of finding problems, with support systems and seeking the root cause to problems when these appear, is something that will enhance the productivity in the long run. According to Liker (2004) the value proposition is driven by the quality for the customer.

Principle 11: Respect your extended network of partners and suppliers by challenging them and helping them improve.

Chopra & Meindl (2013, pp. 13) explains their view of a supply chain: "A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves."

Traditionally for companies in the west world, especially in the automotive industry, is has been common practice to look for suppliers who can generate the most economic sustainable situation for the manufacturing company, by switching supplier sources when another supplier offers better price. With the increasing interest of supply chain management cooperation among suppliers and manufacturing company has become more popular.

Liker (2004) describes the relationship between Toyota and its suppliers as learning and growing together approach, which according to Liker is the highest form of the learning enterprise, to create an extended learning enterprise. His understanding of the Toyota Way is that their definition of respect is rooted in setting high expectations for their suppliers and treat them fair and develop them, not said it is easy to please. It is rather an extension of their views of how they want their own people to be. By challenging the employees, the suppliers have to be challenged. Liker argues that a Toyota supplier handle TPS as good as its own plants in order to deliver high-quality components and a way of teaching suppliers is by working in real projects together with them.

As companies at a wide degree uses modern and advanced information technology when communicating with its suppliers in the belief this will make cooperation better. However, Liker argues that the strength of the supply chain isn't measured in advanced communication facilities; the strength lies in inventiveness and relationships.

Negative criticism argues that Toyota challenge their suppliers too hard but Liker assert rather that Toyota cure suppliers from sickness in a holistic way with provocative standards, procedures and rules and help them accomplish these targets by supporting suppliers with issues spread from technical to human resource matters. In interviews with Toyota employees, especially in the US, information regarding supplier relationship issues was gathered and when a Toyota supplier experience problems that will hurt the supply chain, Toyota acts quick and send representatives in order to collect actions plans to address the experienced problems. In the US there was a supplier improvement committee, which should support problem suppliers, which according to Liker (2004) showed good results.

Cross docking is a common practice in the transport sector and has been so for a time, used by logistics suppliers regarding goods of all kinds. It is almost a necessity to get economy out of transportation from several peers in one region to one or more peers in another region.

In the TPS viewpoint, the cross docking is a part of the flow as well as the flow inside the factory and is seen as an extension to the assembly line. As parts are delivered in sequence into the

factory with a just-in-time concept, the cross-dock structure is a part of the value stream (Liker, 2004). Moreover, the relationship of the supplier and Toyota is seen as important but as well the connectivity between these peers is taken under the wings of Toyota. It is described by the author as a flow-through facility applying the principles of TPS just as the suppliers and the production plant itself are doing.

To conclude principle 11 of Toyota Production system, the suppliers should be seen as an extension of the business. It is important to challenge them with high-set targets and support them so that they will meet these.

3.3 Cross functional teams

Cross-functional Teams (CFT's) are individuals from different areas in a firm such as product development, production, manufacturing and marketing that works together against a specific goal. CFT's can be used to develop new products, making changes in organizations and increase the speed to the market (Daspit et al, 2013). By increasing the cross-functional integration, a company can also improve strategic decisions and make the firm more competitive (Kotabe and Murray, 2004)

Mentzer et al. (2008) states that product management, purchasing, logistics and marketing function are dependent on each other for an effective supply chain management and that these functions has its own functional space, together with the overlap of other functions. Therefor, cross-functional perspectives are necessary to support and perform different supply chain strategies. There have also been studies made by Van Echtelt et al. (2007) saying that mixing Purchasing and Supply Chain Management with Research and Development functions enables a positive implementation when involving suppliers in the development of new products.

To gain efficiency in the supply chain it is important that companies don't protecting the individual functions and encourage participation across the business functions. It is also important to involve management from every function; otherwise there is a risk that these managers weaken the intentional effort (Lambert et al, 2006). Several authors (Foerstl et.al, 2013, Lambert et.al., 2008) state that functional coordination are even more important for improving purchasing and firm performance than cross-functional integration. Most companies are organized as business functions where every individual is trying to optimize their own function instead of thinking of the overall performance of the company.

Even if the literature mentions the importance of an increased cross-functional collaboration between functions, there are authors that suggest that companies should focus on the coordination of the processes within every function. (Lambert et al, 2008). Some reasons might be that because a cross-functional team contains members with different specialized expertise, the knowledge and perspective might create communication barriers between and among member, which can create conflicts and disharmony between functions (Majchrzak et.al, 2011). Another reason could be that the time for making decisions is decreasing (Eng, 2005).

3.4 Measuring the Supply Chain Performance

Gunasekaran et.al. (2004) write that the key in producing value for the customer comes from providing the customer with a quality product, on-time, and maintaining the customer satisfaction by providing a flexible service system design to respond to the customer needs. The authors argue that an accurate customer query time is essential in keeping the customers

satisfied. A holistic perspective of what through history is called logistics is the term Supply Chain. Firms have become aware of the importance of controlling its expenses and in look for saving potentials all over its supply chain.

Companies acting in our global society are facing even increasing competition from other organizations, something that decrease the margins on the products sold. Lately, the interest in controlling the supply chain as a tool for increasing the profit and in the end the competitiveness of an organisation has increased substantial. Gunasekaran et.al. (2004) continues arguing that in order to improve performance in a supply chain and attain supply chain optimization, control of the processes within the chain is essential.

As continuous improvements have received considerable attention over the latest years, the control of the processes all over the chain has become even further clear. In the present environment the scope of Supply Chain Management (SCM) has developed and expanded. Dealing with SCM today includes a greater integration of suppliers within the organizations. Evidence has shown that integrating suppliers in processes of product development can give substantial decrease of the total product development i.e. Lynch & Cross (1991) argues that the overall service chain performance comes from efficiency and effectiveness of each activity and actor in the chain; in terms of for instance customer satisfaction, flexibility and productivity.

In order for a company to be able to control its supply chain performance measurement metrics has been used as one key, amongst others, for a long time and especially within manufacturing companies. Without measurement it can be difficult to actually see and experience changes. In the point of view of Cooper and Fawcett (1998) they think that performance measurement must help the organization to translate the customer's needs in order to be able to tailor products and services that fits those needs. The authors understanding are that modern companies really are compulsive about their performance measurement efforts. Further, the performance measurement used properly is competitive power and lead to better decisions (Cooper and Fawcett, 1998). However, companies fail in maximizing the full potential of their supply chain as they haven't developed performance measures and metrics needed for a fully integration of their supply chain in order to maximize its effectiveness and the efficiency (Gunasekaran et.al, 2004).

An important aspect stated by Schroeder et.al. (1986) when using performance metrics, is that all its members should fully understand the measurements and that these metrics should offer minimum opportunity for manipulation. The metrics used when assessing the performance of the chain should also be created in line with the overall goals of the organization.

To be able to experience results of deviations in the environment surrounding the supply chain, for instance process changes, the measurements metrics need to kept within a set limit and remain relatively constant (Gunasekaran et.al, 2004). It is important that the used metrics for measuring the performance at the moment as well as after improvements have been introduced are those that capture the essence of the organizational performance (Gunasekaran et.al, 2004). In the transition to the information age Cooper & Fawcett (1998) argues that with a steady increase, in percentage, of customer orders done through electronic data interchange it further enables precise supply chain performance evaluation.

Below a list of typical performance metrics are presented (Gunasekaran et.al. 2004).

- Order lead-time; a common metric that capture the time spent from that an order is received until delivery of finished goods to the customer. Also known as order to delivery cycle time. Christopher (1992) argues that this metric is of higher importance since it directly interacts with the customer service in determining competitiveness. A reduction of order cycle time will contribute in a positive way to the responsiveness of the supply chain.
- The customer order path is the metric describing the path of the order. Here one can determine time spent in different activities before the order is delivered to customer. This is also used as a metric to minimize non-value adding activities in the supply chain.
- Supply link evaluation is a set of metrics used to evaluate the supply link. It consist of strategic (top management) level with measures that include quality level, cost saving initiatives, lead time against industry norm or supplier pricing against market. In the tactical level, middle manager level, measures could be purchase order cycle time, booking in procedures, cash flow, quality assurance methodology or capacity flexibility. At the lowest level, the operational, measures like adherence to agreed delivery schedule, number of complaints or defect free deliveries.
- Product and or service range; metrics that measure the profitability of a set of products or offered services to customers. A company can offer a wide or narrow range of products which all contributes different to the profit of the company and its supply chain. Metrics like production speed, delivery reliability or value added per employee are common in this category.
- Further common metrics are on-time delivery (which reflects the ability to deliver products upon agreed delivery time) as well as customer query time that is a customer satisfaction metrics, the time spent from a customer question until they get the answer and how accurate this answer was.

The importance of financial measures

Highly often used measures are those fitting into the financial segment. Revenue and cost describes the supply chain, at least according to Schary & Skjøtt-Larsen (2001). The authors argue that no other source than cost data provides more detailed information. According to Solvang (2001), the cost is also the most important performance metrics for the supply chain. Further, new means of achieving competitive advantage is supply chain cost reductions says Su and Lei (2008). An assessment of the financial impacts from high-level management level strategies and practices is necessary since it contribute to the flow of product in the supply chain. Financial measurements are seen as strong arguments when implementing changes as it clearly shows expenses or incomes.

Supply Chain Costs, SCC, are those related to the activities of order handling, purchasing and stock handling (Bowersox & Closs, 1996). Hoole (2005) has found that reducing costs in mature supply chains occur more quickly compared to those with less mature supply chain. Further, same author argues that it is common that 5-6 % of the revenues of a supply chain are related to Supply Chain Costs. However, a common behaviour that has been identified related to SCC is that individual units within a company tries to minimize its own costs without considering the whole supply chain due to the often occurring budget restrictions set up by top management. This can occur both in the own organization and between units in another company (Hosang & Bongju, 2005).

4. Empirical Findings

This chapter is describing Volvo Car Corporation and Volvo Cars Customer Service. Further a description of customer order classes and the concept of Direct Delivery Global Supply followed by a descriptive section presenting the supplier for the master thesis, Plastal and its production plants. Finally, the bumper delivery from Plastal Raufoss to dealers in different markets will be clarified together with lead-time calculation for the Swedish and north German dealers. The section will give the reader an overview of the activities in the supply chain from the focus factory in Raufoss to the dealers in the covered markets.

4.1 Volvo Car Corporation

Volvo Car Corporation (VCC) and their subsidiaries are active in the automotive industry, where design, development, manufacturing and marketing of cars are the main activities. The head office is situated in Gothenburg, Sweden, and the company is a wholly- owned subsidiary to Geely Sweden AB, a Chinese company who bought VCC in 2010. The starting point for Volvo occurred in 1927 where the first model presented, the ÖV4, and they have during the years produced over 70 different car models. During 2012 Volvo sold more than 429 000 cars worldwide and their turnover the same year where around 106 000 MSEK (Volvo, 2012). In the end of 2011 Volvo globally engaged over 21 000 employees where around 15 000 of these work in Sweden (Volvo, 2012).

4.1.1 Volvo Cars Customer Service

Volvo Cars Customer Services, VCCS, is the unit, responsible for handling spare parts and accessories for the aftermarket to all produced cars made by Volvo Cars. The policy for the company is to offer spare parts for a specific car model, up to 15 years after final date of production. The function *Purchase Planning* within the section *Material Supply* has the task to ensure stock availability at the lowest possible cost for the whole assortment that VCCS is providing.

VCCS uses four major market channels to reach out to their customers. The first market channel they use is a warehouse where they store almost all available spare parts. It is placed in Torslanda, Gothenburg and the name for this warehouse is Central Distribution Centre and will further on be named as CDC. The warehouse is placed in Torslanda, Gothenburg. The second market channel used is National Distribution Centres or from now on called NDC. These are smaller warehouse similar to the CDC in assortment, but these are placed in North America, Asia and Australia. The third channel is the Support Distribution Centres or from now on called SDC's. The function of these warehouses is almost as the NDC's but these are placed around Europe. The fourth channel is the Local Distribution Centres. These are placed closer to the customers, with a smaller assortment then CDC and NDC's. The market channels are built as a hierarchy and if an item is missing at the LDC's the product is sent from the closes distribution centre one level above. A more detailed presentation of the market channels will be presented below.

Central Distribution Centre

The Central Distribution Centre (CDC) in Torslanda (Gothenburg) is head building for storing all VCCS spare parts in the world. It provides more than 100 000 part numbers covering an area of

around 110 000 square meters[1]. The products in the CDC are stocked and then delivered to customers when an order is received.

National Distribution Centre

The National Distribution Centres (NDC) are placed in markets overseas, such as USA and Japan. These NDC's keeps stock of the most used spare parts for the aftermarket, partly to decrease the lead-time to customer, but also to reduce the transport inventory. The NDC's get their products from the CDC in Torslanda.

Support Distribution Centre

The Support Distribution Centres (SDC) are located in Europe and these SDC's are a smaller versions of the CDC. They store almost the same numbers of spare parts as the CDC, but in smaller number per article. The SDC's also receive their products from the CDC in Torslanda. The reason for having the SDC's is go get closer to the customers, to reduce the lead-time.

Local Distribution Centre

The Local Distribution Centre (LDC), are strategically located in a couple of market around Europe. About 45 % of the EU market is covered with the concept and customers within the LDC concept cover around 90 per cent of the sales[2]. The LDC concept is a concept launched around a decade ago and the principle behind this concept is to supply the dealers with spare parts up to three deliveries each day and the dealer can choose which time during the day they want to have the spare parts. The LDC's support dealers in their close surroundings with both daily and overnight deliveries. With basis in lean logistics, the concept enables the dealers to get deliveries just in time for the repairing of the car. At the moment there are five LDC covering Sweden based in Gothenburg, Malmö, Stockholm, Jönköping and Örebro.

Each LDC has a stock of frequent articles and is supported by the CDC. With the LDC concept, VCCS is increasing the customer value with faster and more efficient service, increased parts availability and reduced lead times. The system creates less variation and enables the dealers to reduce their inventory since the system is based on customer demand. Further advantages both for VCCS and the customer are increased profitability due to improved parts availability (fewer stock outs or shortages), increased sales and greater dealer loyalty.

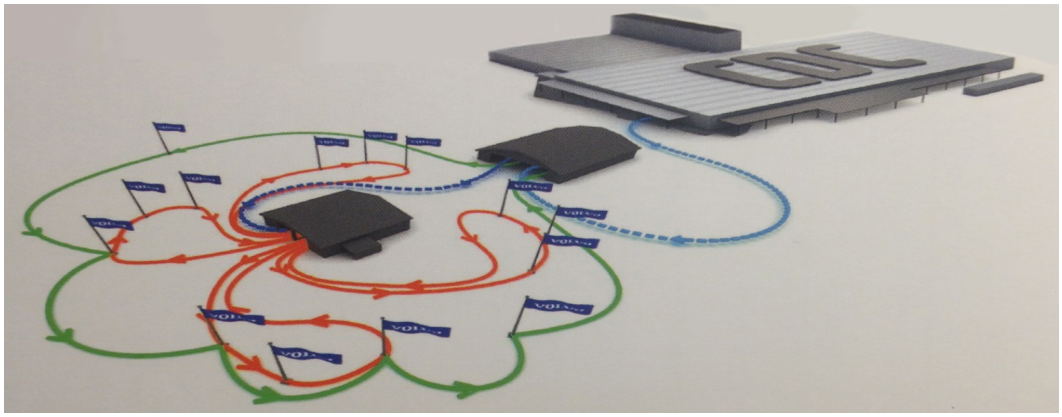

Figure 6: The Principal LDC structure (Master Magazine, nr. 1, 2013, pp. 20)

[1] Sandra Johannesson (Purchase Planner, VCCS) interviewed 14th of January 2014.
[2] Anders Larsson (Distribution Concept, VCCS) interviewed 27th of November 2013.

Figure 6 shows the LDC concept. The green line indicates pre-planned orders, which is received during night or early morning the same day at the dealers (the blue flags). The daytime deliveries (red lines) occur 1-2 times per day.

4.1.2 Direct Delivery Global Supply

The implementation of the DDGS concept was introduced in year 2000 and the channel is used for front and rear painted bumpers, winter tires and keys. This channel enables the product to be transferred directly from the supplier to the customer, without any intermediaries. The concept is illustrated in figure 7.

Figure 7: Representation of direct delivery structure

A reason to the implementation of the DDGS distribution structure was the increasing number of variants that made the products inefficient to stock in the warehouse. VCCS has a policy saying that they shall provide spare parts up to 15 years after end of production, which further increased the number of articles to stock in CDC. The tires and the painted front and rear bumpers requires large warehouse space as well as they infer big warehousing costs due to the amount of variants each group covers while the keys for instance has to be programmed to fit to a specific car model.

VCCS has an ambition to increase the range of DDGS product groups, due to the growth of articles and the warehouse space limitations. An advantage with this concept is that Volvo Cars can secure a higher average paintjob quality on the bumpers. The bumpers where earlier painted locally at each dealer and the experience Volvo gained was that the quality differed substantially between markets and dealers. The development of the DDGS concept has shown to be an important business for VCCS where only the painted bumpers stands for around 3 % of the total sales in 2013.

The overseas markets; Canada, USA and Japan are receiving painted bumpers but in contrast to the Nordic and European market the setup is built though the NDC's who keep stock of painted bumpers and not with direct delivery principles as in the case of Europe. Plastal replenishes the NDC stock at regular basis. In the case of European dealers DDGS bumpers is used as a common phase when discussing painted bumpers, meaning that Scandinavian markets and northern German dealers use the DDGS setup without intermediaries while the other markets in Europe use a light-version of a DDGS setup. In their case the system in configured as a DDGS flow but the flow is monitored physically with few intermediaries.

4.1.3 Order classes

VCCS uses different types of order classes, ranging from class 4 to class 0, to determine how important an order is for the customer and how fast the customer wants the product. Class 4, often called refill order, are mainly used for refilling of the distribution centres overseas or to the SDC's in Europe from CDC. The lead-time for these orders is longer than other order classes and should be a maximum of seven working days. Class 3 orders are used for articles when the need of the product is known in advance, for example a car will be repaired Friday the upcoming

week. Class 1 orders are used for products when the need of the product can't be predicted in advance, with high importance of short lead-time. For example products for a collided car, that needs to be repaired in one or two days. Class 0 order can only be used for products, if the car is not drivable without this specific product, an emergency order. The lead-time on emergency orders is "as fast as possible", which mean that VCCS uses all possibilities to deliver the product to the customer as fast as possible, often the same day or next day. For this class order, airplane can be used even for short distances. The order classes are summarized in table 1.

Table 1: Types of customer orders

Order class	Type of order	Deliver lead-time
Class 0	Products for a car that is not drivable without the product	As fast as possible. Often the same or next working day
Class 1	For products when the need can't be predicted in advanced	High importance of short lead-time. Often one to three working days
Class 3	For products when the need of the product is known in advanced	Depending on when the customer wants the products
Class 4 - Refill	For products going overseas to refill a warehouse	Long lead-time. Up to seven working days

The customers decide themselves which type of order class to use, whether they need a product fast or not. The price differs depending on whether the customers are connected to the LDC concept or not. For the customers who are connected to the LDC concept there is a surcharge of 11,5% on the basic price, independent of which order class they use. The gain for these customers is that they don't need to stock articles and are provided with articles 2-3 times each day.

For those customers who are not connected to LDC there are different surcharges depending on the order class. For class 4 orders, they price is a basic price, instead these orders have a longer delivery time. For class 1 orders, there is a surcharge of 15% on the basic price and for these orders the aim is to deliver within 2 working days. For class 0 orders, the surcharge is 20% on the basic price, with deliveries within 24 hours from order. Table 2 shows the different prices for different order class.

Table 2: Surcharge for the order classes depending on whether a customer is connected to LDC or not.

Connection to LDC	Price on order class
YES	11,5% extra for every order class
NO	20% extra on Class 0 15% extra on Class 1 11,5% extra on Class 3 0% extra on class 4

The DDGS assortment at the Swedish market has another price structure. Here, painted bumper can be found. For the bumpers, the dealer will not be charged any extra on the basic price, no matter if the dealer is connected to an LDC or not.

4.2 Plastal

Plastal is a supplier of internal and external plastic-systems for the automotive industry and their main product are bumper systems. Their strategy is to work against a well-defined market segment, where premium cars with strong brands and medium-heavy vehicles in Europe are the

main focus. Their main customer is Volvo Cars Corporation, but according to Plastal Raufoss' spare parts coordinator they also provide plastic components to other companies such as Orio, former Saab Automobile Parts. The head office and a production facility is situated in Gothenburg (Arendal), Sweden, but they also have production sites in Gent (Belgium), Raufoss (Norway) and Simrishamn (Sweden). Table 3 shows sales and employees for all sites in 2012 (Plastal, 2013).

Table 3: Sales & Employee figures at Plastal in 2012

	Sales (MEUR)	Employees
Gent	65	220
Gothenburg	40	215
Rausfoss	20	150
Simrishamn	30	160
Total	**155**	**745**

The product range can broadly be divided into exterior and interior plastic components for the automobile industry. Exterior products include painted bumper systems and chromium plated grills. For the interior sector, Plastal produces decorated trim details or even complete instrument panels.

The production is done by a high variety of injection moulding-, plating- and surface-treatment machines. The offered services range from preliminary analysis, simulations and prototyping via production to the delivery of the products. This goes both for serial production and for spare part concepts. The volumes differ from very low frequent products to high frequent serial parts. To allow a Just-in-Time approach for the customers, production plants are placed close to the customer plants and ordering- and production processes are managed in order to allow very short lead times. Table 4 gives an overview of the producing plants and which Volvo car model that is produced where.

Table 4: Models produced at each Plastal production facility

Producing plant	Models
Arendal	V60, V70, XC70, S80, XC90
Gent	V40, V40 Cross Country, S60, XC60
Raufoss	Models no longer in production. Painting for colours no longer in production for Arendal and Gent.

Plastal Arendal, Gothenburg

The plant in Arendal produce bumpers for the car models made in the Volvo Cars serial production factory in Gothenburg, currently Volvo V60, V70, XC70, S80 and XC90. The production of bumpers contains moulding, painting, assembling and packaging. Arendal produce bumpers for current car models until there is are change in the design of a bumper or when a colour from current models is removed. Then the production of these bumpers is moved to Plastal in Raufoss.

Plastal Gent, Belgium

The production plant in Gent produces bumpers for all car models made in Volvo Cars Gent factory, currently Volvo V40, V40 Cross Country, S60 and XC60. The production process is the

same as in the Arendal plant and as in the case when a colour is phased out from serial production or a change of design the production is moved to the Raufoss factory.

Plastal Raufoss, Norway

The production plant in Raufoss produces bumpers for cars that are not in production anymore, namely spare-part bumpers. However, the plant is also responsible for painting bumpers for car models who are still in serial production but when Volvo has decided to remove a colour out of the serial production. Further, Raufoss paints the bumpers produced in Gent but where the customers are placed in northern Germany or Scandinavia. The reason to this setup was an investigation, which showed that the time for producing a bumper in Gent, shipping it to Raufoss for painting and then transporting to customers in northern Germany or Scandinavia took less time than producing, painting and transporting a bumper from Gent to these markets.

The factory produce approximately 3 100 bumper variants to the aftermarket, the amount of variants is due to the VCCS policy to provide spare parts for a specific car model up to 15 years after final date of production. The tools for making the bumpers are big both in size and weight. The size can differ from 4 square meters up to 10 square meters, while the weight is between 5 and 40 tons.

4.2.1 Bumpers manufacturing process at Plastal Raufoss

The front and rear car bumper is made in plastic, originally generated from granules. The manufacture of a bumper in Raufoss is divided into four steps, starting with the granules that are injected in a moulding machine (there are three moulding machines inside the Norway plant) where the output is a black bumper. After the moulding the bumpers is transported to the painting section, where two layers of paint is applied. The first layer is a protecting layer while the outer layer is the visible colour. In the plant Plastal has one automatic painting section and one manual painting area. The manual section is mainly used for difficult bumpers shapes and unusual colours. When the paint has dried, the third step is the punching section where holes for parking sensors etc. are made. Here, 30 different machines can be used. The bumper is now finished and are packed into Volvo packaging and put into the warehouse or directly to delivery. Figure 8 shows an example of front and rear bumper for Volvo V60.

Figure 8: Examples of Front and Rear bumper for Volvo V60

4.3 The order processes of bumpers

This section describes the order process, starting with a customer order until the ordered product arrives at the customer. It includes how the dealer decides which type of bumper they should order, the type of order class, how the bumper is transported from producer to customer and the lead-time to different customers.

The overall bumper flow differs depending of where the customers are located. Customers located in Scandinavia and northern Germany the orders is sent to Plastal in Raufoss while customers from other parts of Europe get their bumpers from the SDC warehouse in Maastricht. The Maastricht warehouse in turn orders from the Raufoss factory when their stock is running low.

Deciding bumper type and order class

A dealer decides to order a new bumper upon request from the car owner or based on the dealers view that the bumper is enough damaged and couldn't be repaired. The reseller is equipped with a computer system where they can order bumpers directly from VCCS. To determine the bumper type that is needed for the specific car, the reseller either needs to see the car or the reseller can enter information about the car in the computer system. This information contains the license plate number and VIN-number, Volvo Identification Number, which is a part of the chassis number.

A reseller can choose if the order on the bumper should be either class 1 or class 3. Class 1 is used in cases where the bumper is needed right away. This order class is mostly used when the bumper is so much damaged that the car is not inoperable. The lead-time for a bumper class 1 should be 3-6 working days[3]. Class 3 orders are used when there is no need of fast deliveries of the bumpers and this type is often called pre-planned order. The type is used for instance when the repairing of the bumper can be made together with the next service of the car.

Data communication

Volvo Cars has an EDI (Electronic Data Interchange) connection towards its suppliers and its dealers. There is a market/sales company (SC) for each region where Volvo Cars is operating, split into a specific country or a region consisting of several territories. The car dealers are connected to the SC in its region and the communication between Volvo Cars and the dealers is on first hand between these parties, the communication in different dealer issues is then communicated to Volvo Cars via the SC.

Volvo Cars dealer is using a system called DMS[4] (Dealership Management System), which is a computer system who provides information that helps an organization with efficient information transfer. This type of computer system is specifically created for the automotive industry and often contains software that supports a dealer with information regarding inventory levels, finance and administration etc. and can be seen in figure 9.

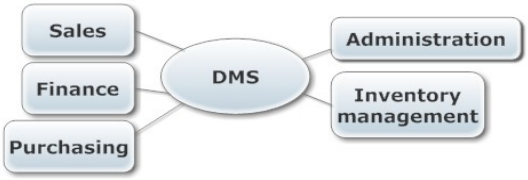

Figure 9: Basic DMS representation

Data communication between the sales company and the dealers is carried out through a common application system (CAS) which is a communication module in the sales company's computer system VIPS, called Volvo Vision. This system is mandatory in order for the dealers to carry out an order towards SC and VCCS. Within Volvo Vision the dealers also gain access to other modules where two is worth mentioning; VIDA (Vehicle

[3] Annika Forslund (Dealer support Order & Delivery, Volvo Cars Corporation) interviewed 5th Dec. 2013.
[4] Henrik Dahlbom (Business Application Manager, Volvo Cars Customer Service) interviewed 11th Nov 2013.

Information & Diagnostics for Aftersales) and TIE[5] (module for reporting technical and quality issues). These modules of software's aim to further provide the dealers with information regarding ordering and quality remarks i.e. VIDA is a catalogue system, which provides information about a specific car model based on i.e. chassis number or license plate. This module contains all information regarding parts, components, pricing, engines etc. of Volvo Car products, both new and old[1]. TIE on the other hand is an information system aiming to assist the dealer in for instance in making quality remarks. When a quality remark is done in TIE, the reports are sent to the sales company's CAS, VIPS, where the SC examines the remark and approve or decline the request[6]. The figure 10 shows an own representation of the computer systems and their communication paths.

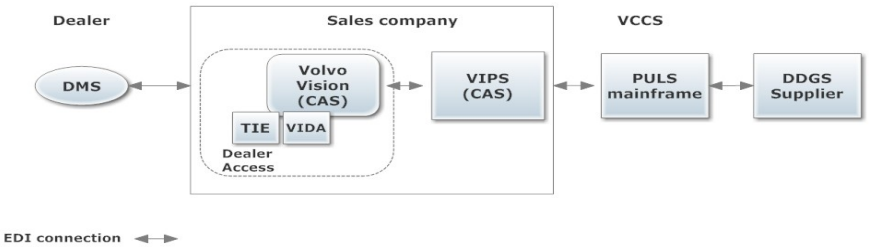

Figure 10: Representation of data communication path and its components.

The sales companies CAS are connected to VCCS's part supply system. From VIPS an order is transferred to PULS (Parts Universal Logistics System) of Volvo Cars. In a standard order of spare parts, PULS register the order and check inventory levels; if the inventory is satisfactory a signal is sent to the warehouse personnel for processing. Otherwise the signal is sent to purchase planning department who need to call off material from the supplier in order to fulfil the order from the dealer.

PULS are a highly integrated logistics system, which is used for several purposes within the organisation. Volvo Cars Parts Supply & Logistics uses it for, among others, inventory and quality management for instance. According to Marx and Zimmerman (2005) PULS was developed in the 1980s with purpose to be the mainframe system for handling the spare parts business. It is built up in different modules including procurement, price systems, distribution center refill, parts planning etc.

For DDGS parts on the other hand the setup is slightly different. A DDGS part order process looks the same from the dealer and sales company's point of view but when the order reaches PULS it will only be registered as an order and there will be no inventory check for these articles. PULS will register amount, date and time for the DDGS part and the order is sent to the supplier of the specific part for processing.

Supplier communication

When VCCS communicate with its DDGS suppliers there are two options available at the moment. One called light version and one where the supplier and VCCS computer systems are deeply integrated[1]. The light version is a web based communication system where the supplier gets order from VCCS through a specific web portal. This light version is offered to some suppliers due to long implementation time and the costs inquired by the normal setup. However, a supplier using the web portal option is given the equal options and features as a greater

[5] Seppo Lintanten (Product Manager, Volvo Cars Corporation), interviewed 2nd Oct 2013
[6] Karin Nikolouzos (Volvo Parts Supply & Logistics) 7th Oct 2013

integration, although in a minor scale[7]. When speaking of the integration option, the suppliers data system is integrated into VCCS data system and communication between the parties occur simultaneously. The parties can send real time information about particular order processes, i.e. order change questions or delay information and billing inquiries.

4.3.1 Incoming orders to Plastal Raufoss

When an order enters Plastal 's computer system, the system is checking if the ordered bumper is available in stock. If the bumper is available, it is picked and prepared for shipping. Otherwise it has to be produced. The spare parts coordinator in Raufoss says that if Plastal have 5 000-6 000 bumpers in stock, chances are 70-80% that the bumper is available. For Nordic customers Plastal can produce, paint and prepare the bumper for shipment before 22:00 if the order has arrived at Plastal before 13:00 the same day. If the order has arrived after 13:00, the date for shipping will be next working day at 22:00.

The order class on the bumper can be either 1 or 3, which is determined by the dealer when placing the order. However, an order can also be a class 4 but this order class is only used for the SDC in Maastricht or for the overseas market. When a dealer makes an order the order is transferred to PULS who registers the order and with pre-determined parameters gives the order a ready for shipment date. From the order PULS automatically collect information about requested amount from the dealer, ready for shipment date, order class and then transfer the order to the supplier. The parameters that gives the order the ready for shipment (RFS), shipping date from supplier, is set in accordance with the supplier and is stating the amount of days that the supplier need to complete the production process of an article.

In the agreement between VCCS and Plastal it is written that if a class 1 order for the Nordic markets (Scandinavia and northern Germany) enter Plastal's system before 13:00 (cut-off time) day 1, the order must be ready for shipping before 22:00 the same day. For class 3 and class 4 orders that enter the system before 13.00 day 1, the time for shipping has to be before 22:00 the following day. For the Europe market (southern Germany and rest of Europe) there is no difference between the order class and every order that enters the system before 13:00 day 1 must be shipped from Raufoss before 22:00 the same day. For refill orders, class 4 orders to SDC in Maastricht the delivery time is 22:00 day 4 if the order enters the system before 13:00. It is based on these parameters that the system calculates when the order needs to be finished. Table 5 summarizes the calculated delivery date for different markets and order classes.

Table 5: Plastal's delivery parameters

Market	Order class	Cut-off time	Shipping time
Nordic markets	Class 1	Before 13:00, day 1	< 22:00, day 1
Nordic markets	Class 1	After 13:00, day 1	< 22:00, day 2
Nordic markets	Class 3 and Class 4	Before 13:00, day 1	< 22:00, day 2
Nordic markets	Class 3 and Class 4	After 13:00, day 1	< 22:00, day 3
Europe market	Class 1-4	Before 13:00, day 1	< 22:00, day 1
Europe market	Class 1-4	After 13:00, day 1	< 22:00, day 2
Europe, Refill Maastricht	Class 4	13:00, day 1	< 22:00, day 4

[7] Henrik Dahlbom (Business Application Manager, Volvo Cars Customer Service) interviewed 11th Nov 2013.

4.3.2 Transportation

When a bumper is produced, it is ready for transportation to the customer. The customer's location can roughly be divided into three market areas: Scandinavian and northern Germany, Southern Germany and rest of Europe and finally Overseas. For the customers located in southern Germany and rest of Europe, the bumpers are shipped from the SDC in Maastricht. The following sections will present the transportation setup to each of these three market areas.

4.3.2.1 Bumpers for Scandinavia and the northern German market

A customer located in Scandinavia or northern Germany will receive bumpers from Plastal in Rausfoss. As mentioned before, if there is a need of a bumper that produced in current production in Gent or Gothenburg, these bumpers are shipped to Raufoss for painting. There is also a company, Peguform, which ships unpainted to Rausfoss for painting. Peguform is a German based company that produce bumpers for a few older Volvo Cars models.

In Rausfoss the bumpers are painted if the bumpers are coming from Gent, Gothenburg or Peguform. Otherwise the bumper is produced as mentioned in section 4.2.1. When the bumpers are finished and ready for shipment, they are transported to Gothenburg. The truck leaves Raufoss at 22:00 day 1 and after a stop in Sarpsborg in Norway for unloading bumpers for Norwegian customers, the truck arrives around 06:30 day 2 at the LRN terminal in Gothenburg. In the terminal a sorting and consolidating activity with important class 1 bumper from Plastal's factories in Gothenburg and Gent is done. The bumpers are then transported to CDC in Gothenburg, where they arrive 9:30 day 2. The central distribution centre act as a cross docking terminal for this market area. The bumpers are put on trucks leaving CDC 18:00 day 2 and transported to the dealers belonging or not belonging to the LDC concept.

Figure 11 shows the painted bumper flow for the Scandinavian and northern Germany market and how these are transported to the customers. In the figure PAGE is acronym for Plastal Gent factory while PAGO equals to Plastal Gothenburg and PARA stands for Plastal Raufoss respectively.

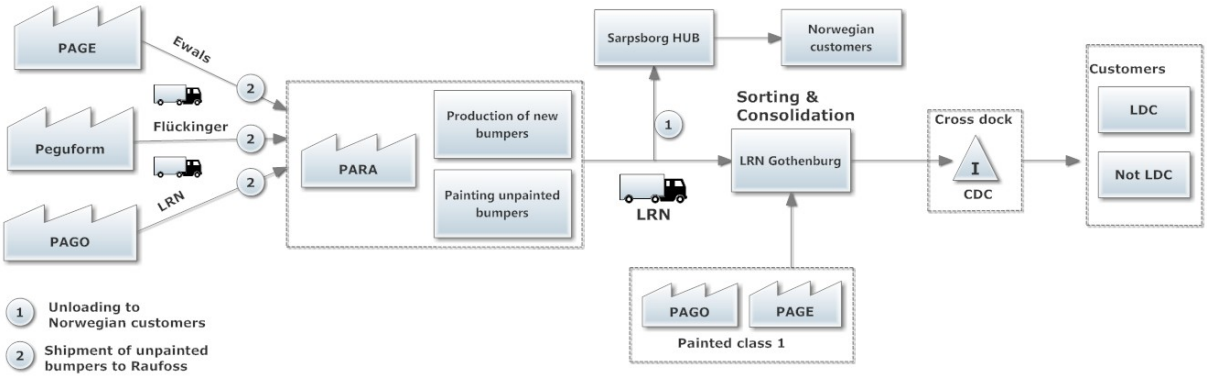

Figure 11: Painted bumper flow Scandinavia & northern Germany

While the setup for the dealers connected to the LDC concept is described above dealer that are not connected to an LDC the setup is arranged in similar manner. The bumpers are transported with regular trucks to the LRN terminal where the sorting occurs. What differs is that these bumpers are transported to CDC for cross docking with other goods that are to be shipped to these dealers. From CDC a transporter drives the goods during the evening and night to a transportation hub where an extra sorting occurs. From the hub a lorry drives in what is called a milk run and sequentially delivers the bumpers to the dealers. Due to the distance between the

hub and each dealer the milk run is split in two parts where dealers close to the hub gets delivery at the same day as the goods arrive to the hub while for distant dealers they will have their ordered goods at day 2. This setup is illustrated in figure 12.

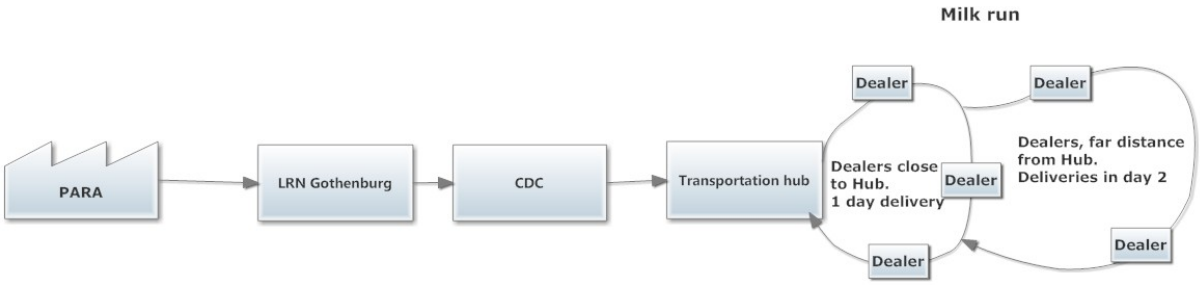

Figure 12: Transportation setup for dealers outside LDC

4.3.2.2 Bumper delivery from southern Germany and rest of Europe

Customers situated in southern Germany and the rest of Europe get their order from SDC Maastricht instead of the plant in Raufoss. If a customer in southern Germany and the rest of Europe orders a bumper, the system check if the bumper is available in Maastricht. If the bumper can be offered, the bumper is delivered to the customer. Maastricht covers around 95 % of the orders, meaning that 95% of the incoming orders are ready to be picked from the warehouse[8]. If the bumper isn't available, the bumper needs to be produced at a Plastal plant. If the car is old or the colour is deprecated the bumper will be produced in Rausfoss and shipped to Maastricht and further to dealer. If the car is new, the bumper will be produced at the plants in Gothenburg or Gent and then shipped to the Maastricht and then to the dealer. The setup for delivery from Maastricht can be seen in picture 13**.** The transportation layout for the three production plants is a straight flow. A transporter regularly drives with a full truckload from these factories without intermediaries to the Maastricht warehouse.

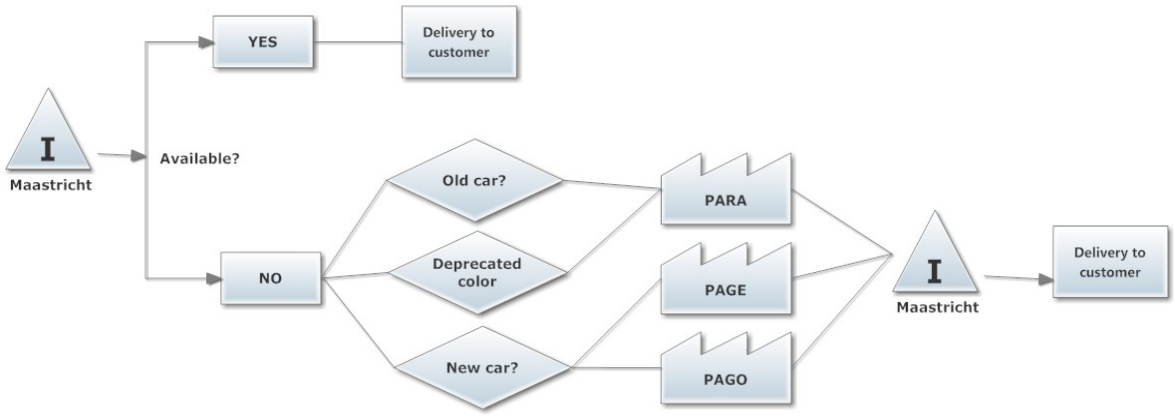

Figure 13: Setup for Europe customers

4.3.2.3 Bumpers to Overseas market

For the NDC in the overseas market (North America, Asia and Australia), the bumpers are shipped from each production plant to LRN terminal in Gothenburg where the bumpers are sorted and loaded into containers. The containers are transported to Gothenburg harbour where they are loaded on freighters for final shipment to the NDC's. The transportation layout is illustrated in figure 14.

[8] Toumo Saaranen (Inventory Manager, VCCS) interviewed 25th of September 2013.

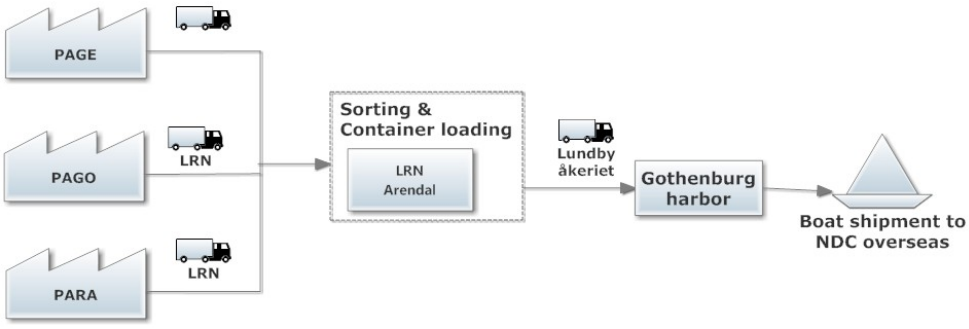

Figure 14: Overseas layout

4.4 Lead-time calculation

This following section describes how the lead-time for the master thesis was calculated and which parameters that were important to consider for determine the lead-time. The section is followed with a summary of the lead-times in working days from customer order until receiving at Volvo CDC, for the German and Swedish LDC's and for the dealers outside the LDC concept in Sweden.

It should be stated that there is no available measure point for when the customer received the bumper and therefor it is hard to clarify if the lead-time is correct. The calculation of the lead-time is based on interviews and e-mail correspondence with team-leaders at the LDC's and it was assumed that the bumpers were received and left the LDC's within the time-windows mentioned earlier

4.4.1 Measure points

Today, VVCS don't calculate the actual lead-time for the bumpers. However, it is possible to calculate the lead-time from customer order to the cross docking at CDC by using the information generated from PULS. Today's setup gives VCCS three measuring points in the bumper flow. The order registration date, which is the first point, is logged in PULS. Further, one point is located at the LRN terminal in Gothenburg and the third point is located at the CDC, namely when the goods leave CDC to its dealers or LDC's. All the points is logged in PULS and can be accessed by generating an excel file over these points from PULS.

Table 6 shows a specific order generated from PULS, converted into an excel sheet. The order contains information about article number, ordered amount, district code (in what country the customer is located), customer code, date order registration date, the date when the bumper arrived at Volvo CDC and date for leaving Volvo CDC. The date when the bumper arrives at CDC is equal to the point at LRN described above. The data used for analysis contained 77 105 different order rows. The examined orders spread over time from 30th of November 2012 until 25th of October 2013. 14 039 of these order rows where connected to Swedish customers.

Table 6: An example of one order row generated from PULS

Article number	Amount of ordered bumpers	District code	Customer code (where the customer is located)	Customer order date	Departure date at LRN	Departure date Volvo CDC
9963915	1	778	101	2013-02-15	2013-02-18	2013-02-18

Table 6 gave three different measure points to determine the lead-time; the date when a customer made an order (1), date when the bumper left LRN (2) and date when the bumper left Volvo CDC (3). Figure 15 shows three measure points for determining the lead-time.

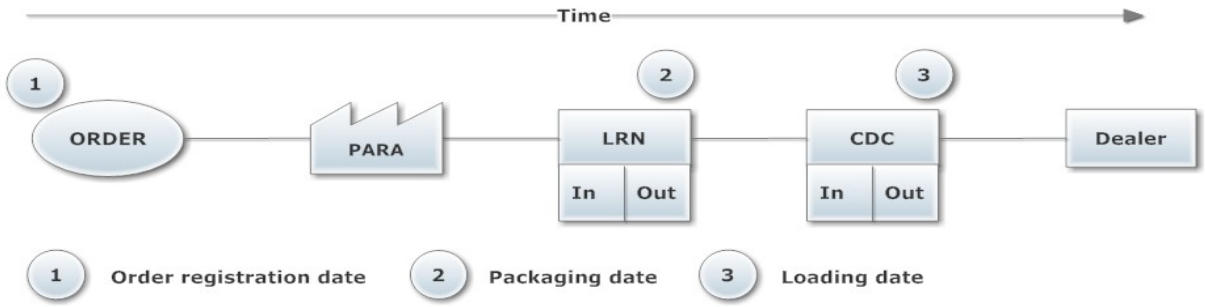

Figure 15: Measure point illustration of the bumper flow

Each article is unique and provides information about that specific article. In this case the bumpers colour, production location and to which car model it fits. Hence, it was important to make a distinction of which Plastal factory the bumper was produced in order to understand the location of the customer. The focus in the thesis is the Raufoss factory.

The amount of ordered bumper is the amount of bumpers the customer ordered. It ranged between one to ten bumpers per order. No distinction was made whether a customer ordered one or many bumpers

The district and customer code shows where and in what country the customer was located. This was important for the Swedish customer, where some of the customer was connected to the LDC concept and some not. For those customers who weren't connected to LDC, the delivery time where at least one day longer.

Further, the date when customer made an order was the date for when the order arrived at Plastal and can be seen in column 5 in the table. The two last columns show the date when the bumper arrived and left Volvo CDC. The difference between these dates can be used to measure if an order is left at CDC. The point with the cross docking setup is that the bumpers shall leave CDC the same day as it came in. Out of 77 105 order rows, 1 090 or 1,41% didn't leave Volvo CDC the same day it came in.

To determine when the LDC received the bumper and when the customer receives the order, it was important to understand which customer that was connected to which LDC, when the bumpers arrived at the LDC, if there were any difference in shipping time between a class 1 or class 3 orders and when the bumper left the LDC for shipping to the customer.

4.4.2 Connecting dealers to LDC

In the end of 2013 around 90 % of the total amount of dealers in Sweden where connected to the LDC concept, while the 10% that are not are mostly originates in the north of Sweden and Gotland[9]. Each dealer is addressed with a customer number, which worked as identification when connecting these to the LDC's. Each LDC supply dealers in their close surroundings and the team-leader from the LDC's in Sweden shared their connected customer codes in order to identify if a dealer who ordered a bumper belonged to a LDC, and in that case which one. The customers outside the LDC concept where identified with assistance from the logistics coordinator at PostNord Logistics AB[10]. With the coupling of each dealer during the examined time frame it turned out to show that there no order made by dealers in the Gotland region and these lead times could therefore not be calculated.

4.4.3 Bumper handling at the LDC

Each working day, the bumpers arrived at Volvo CDC around 10:30. Before 18:30 the same day, the bumpers where placed on a truck with destination to the customer connected to the any LCD or too those customers not connected. The team-leaders provided the time-windows for when the trucks arrived at the LDC's and when the bumper left the LDC. Depending whether the order was a class 1 or class 3, the time-window for leaving the LDC differed. The LDC's in Gothenburg and Örebro made a prioritization of the order, where order class 1 should leave the LDC the same day as it came while class 3 who is less acute did leave the LDC the following day. The time for arrival and departure to LDC for class 1 and class 3 orders are summarized in table 7. Day 1 in table means the following working day.

Table 7: LDC arrival and departure time

LDC	LDC Arrival time	Class 1 departure	Class 3 departure
Gothenburg	10:30, day 0	12:30, day 0	06:30, day 1
Malmö	06:15, day 1	09:45, day 1	Orders treated the same way
Jönköping	06:00, day 1	09:00, day 1	Orders treated the same way
Örebro	06:30, day 1	09:00, day 1	06:30, day 2
Stockholm	06:30, day 1	09:00, day 1	Orders treated the same way

The dealers without LDC connection got their bumpers from a transportation hub, either in Sundsvall in northern Sweden or the hub in the southwest parts in Sweden. However, no orders where identified from customers in the southern part of Sweden and aren't considered. Table 8 summarize the arriving time and leaving time for the bumpers. These customers can't decide if whether a bumper should be of class 1 or class 3, all orders are treated equally. For the hub in Sundsvall, some dealers received their bumpers one day after it arrived at the hub, due to the long travel distance.

[9] Anders Larsson (Distribution Concept, VCCS) interviewed 27th of November 2013.
[10] Mikael Möller (Logistics coordinator, PostNord Logistics AB) interviewed 2nd December 2013.

Table 8: The Sundsvall hub arrival & departure times

Hub	Arriving time to hub	Departure time
Sundsvall	02:00, day 1	15:00, day1 06:30, day 2

4.4.4 Order class determination

The excel sheet generated from PULS didn't explained which order class each order had. The sheet covered information about article number, order registration time, customer number and where the customer was located. The customer number could then be connected to which LDC the customer was associated to and with the article number it was possible to identify the production site for each order. When the distinction of which customer and its orders where identified to an LDC, it was possible to filter out LDC Gothenburg and LDC Örebro. These LDC's used a distinction of Class 1 and Class 3. For the Class 1 orders these left LDC Gothenburg and Örebro the same day as they arrived while the Class 3 left the LDC the following working day. The split in percentage for LDC Gothenburg and LDC Örebro is shown in table 9.

Table 9: Order class percentage

LDC	Class 1 orders	Class 3 orders
Gothenburg	69%	31%
Örebro	71,5%	28,5%

4.4.5 Outline lead-time calculation

The lead-time to the dealers are calculated in working days and therefor excluded weekends and holidays. The focus in this thesis was the bumpers made in Raufoss and it was taken into account of the Norwegian holidays in order to get accurate lead-times in working days. During the holidays the plant in Raufoss was closed and no production was conducted. The days taken into account are listed in table 10.

Table 10: List of Norwegian holidays

Norwegian holidays (until 2013-10-25)	
25th December 2012	**26th December 2012**
1st January 2013	**28th March 2013**
29th March 2013	**1st April**
1st May 2013	**17th May**
20th May 2013	**9 May 2013**

When it was clarified which LDC a customer belonged to and what order class the bumper had, it was possible to calculate the final lead-time for every order. Table 11 shows an example of one order, from the customer made and order until the bumpers were received with added LDC Location and order class.

Table 11: Example of a customer order

Article number	Number of bumpers ordered	Country	LDC Location	Order Class	Date – When customer made an order	Date – Shipping from Volvo CDC	Date – Received at LDC Jönköping	Total working days from order to receiving
9963915	1	Sweden	LDC Jönköping	1	2013-03-15	2013-02-18	2013-02-19	3

4.5 Delivery lead-time

The following chapter present the lead-times to the dealers in Sweden and northern Germany. The lead-times are calculated with parameters described in section 4.4. First, the lead-time to Volvo CDC for Swedish and northern Germany dealers was calculated. The lead-time to the LDC's meaning the total time in working days until the dealers receive the bumpers.

The amount of order from Swedish dealers during the examined time frame counted for 14 038 rows. Out of these, 13 093 pcs where connected to be produced in Raufoss factory. 827 pcs of the remaining order identified as produced in the Gothenburg factory while 118 order rows could not be connected to any factory and has thus not been considered.

The lead-time from order registration to the cross docking arrangement at CDC are illustrated in figure 16. The figure shows the lead-time for an order to be produced in the Raufoss factory and to be shipped, sorted and received at CDC in Gothenburg. One can identify that 89% of the orders occupied only 1-3 working days, while the lead-time in unusual cases occupy up to 25 days. The lead-time calculations until leaving CDC is based on information received from PULS and therefore more accurate than from this point and beyond.

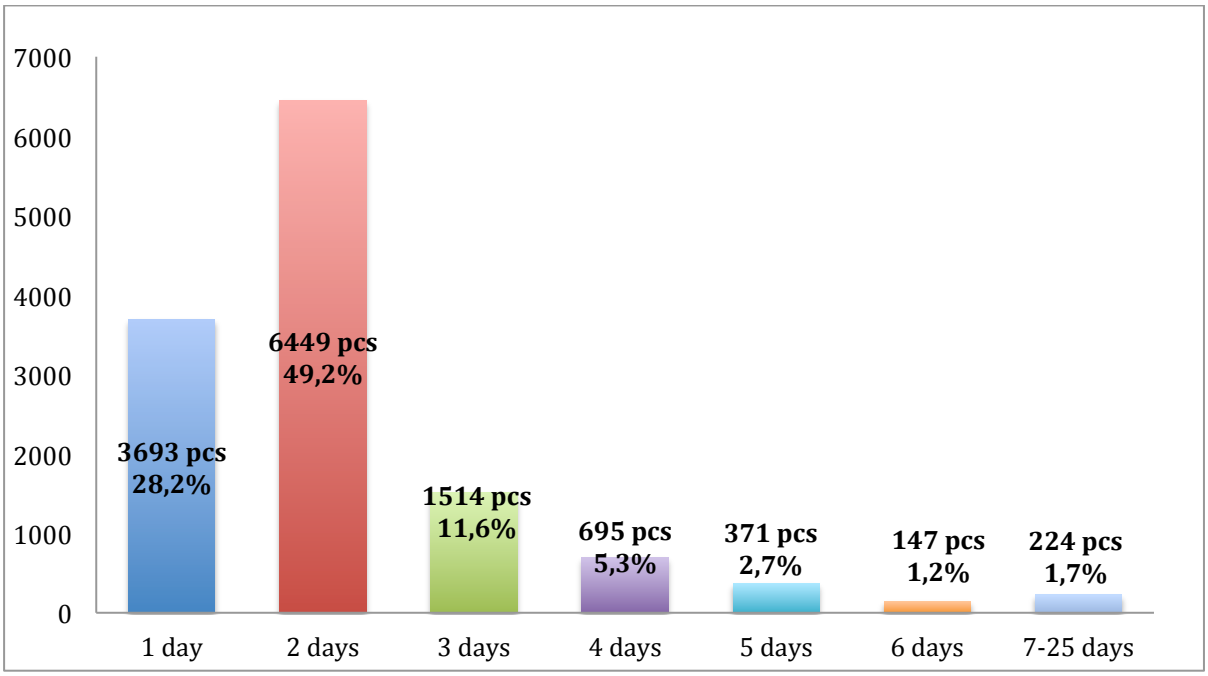

Figure 16: The amount of days from Swedish customer made an order until arrival at Volvo CDC

The amount of order from German dealers during the examined time frame counted for 2 542 rows. Out of these, 2 204 pcs where connected to be produced in Raufoss factory. The lead-times are illustrated in figure 17. The figure indicates that 72,1% orders occupied only 1-3 working days, while the lead-time in unusual cases occupy up to 104 days.

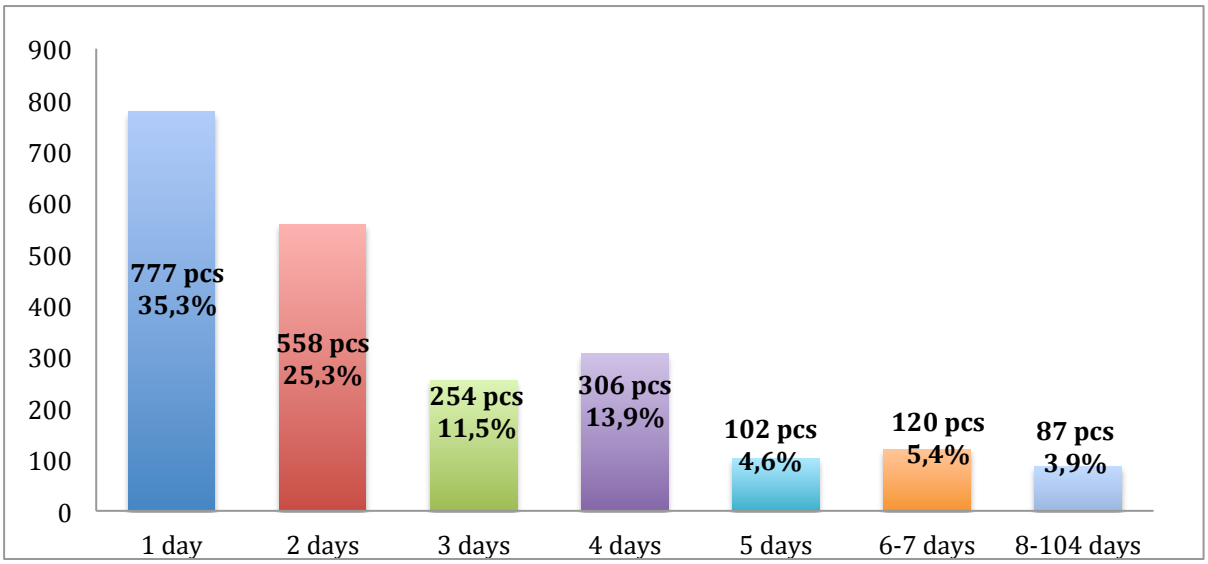

Figure 17: Lead-time from German order until received at CDC

4.5.1 Lead-time from Plastal Raufoss to all dealers connected to any LDC in Sweden

Figure 18 shows the delivery time, in working days, from a dealer made an order of a bumper until it was received at the dealers, connected to any LDC in Sweden. The total amount of orders to LDC for the period in Sweden was 11 997 bumpers. In this figure, no classifications between orders are made, only a summary of all orders from Plastal Raufoss to LDC. As seen in the picture, the time window for 3-6 working days (as promised by Swedish sales company to the dealers) covers 96,6% of all orders.

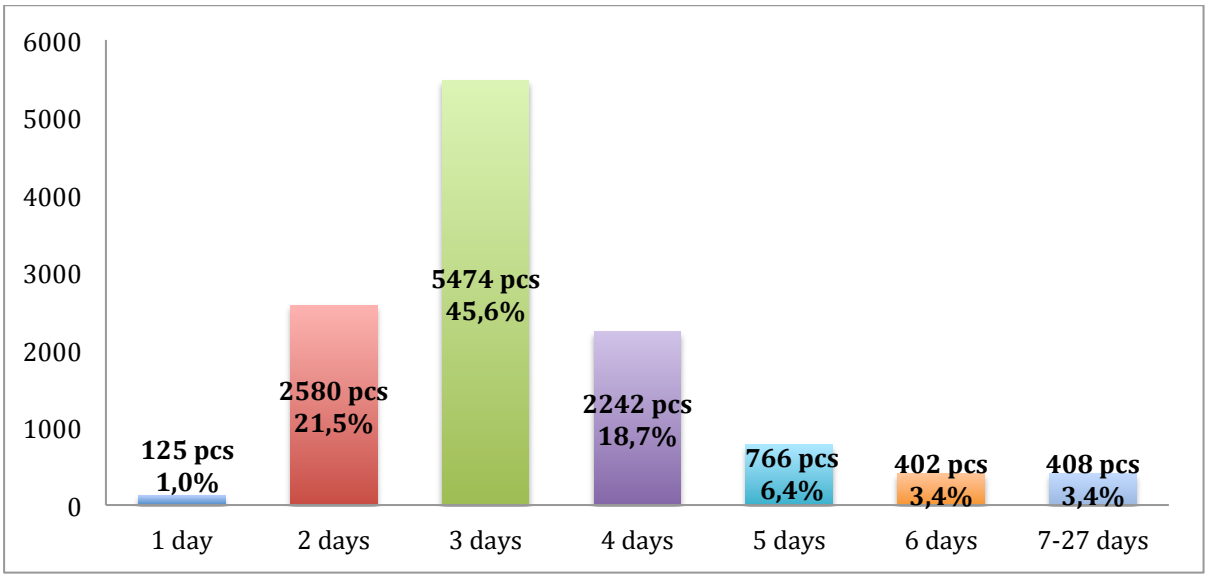

Figure 18: Lead-time from Plastal Raufoss to all dealers connected to any LDC in Sweden

4.5.2 Lead-time from Plastal Raufoss to dealers connected to LDC Malmö

Figure 19 shows the delivery time in working days from a dealer made an order of a bumper until arrival at the customers connected to LDC Malmö. The orders during time examined to LDC Malmö connected dealers were 1 543 pcs. In LCD Malmö, every order was treated the same way and there was no difference between class 1 and class 3 orders. 95,7% over the orders is covered within 3-6 working days.

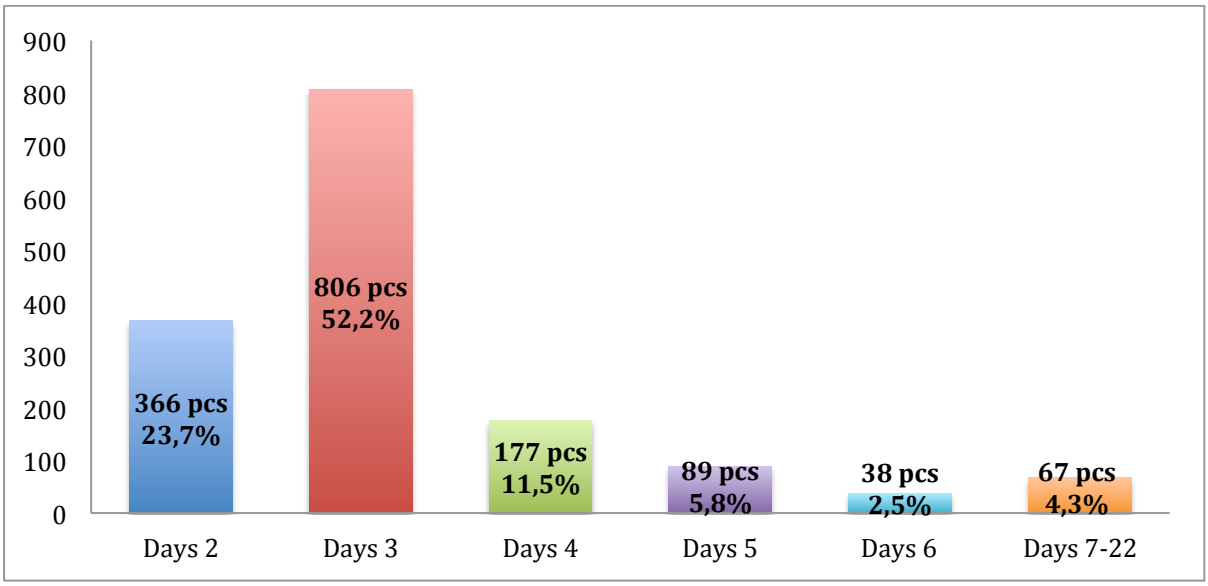

Figure 19: Lead-time from Plastal Raufoss to dealers connected to LDC Malmö

4.5.3 Lead-time from Plastal Raufoss to dealers connected to LDC Jönköping

Figure 20 shows the total amount of ordered bumpers to LDC Jönköping was 1 382 pieces. In Jönköping each order is treated in the same way, meaning that they do not make a differentiation between class 1 or 3 orders. In this case the LDC send the bumpers with their regular transports during the days. In 93,8 % of the cases the bumpers are delivered to dealer within 5 working days but there are a few orders that took up to 19 days.

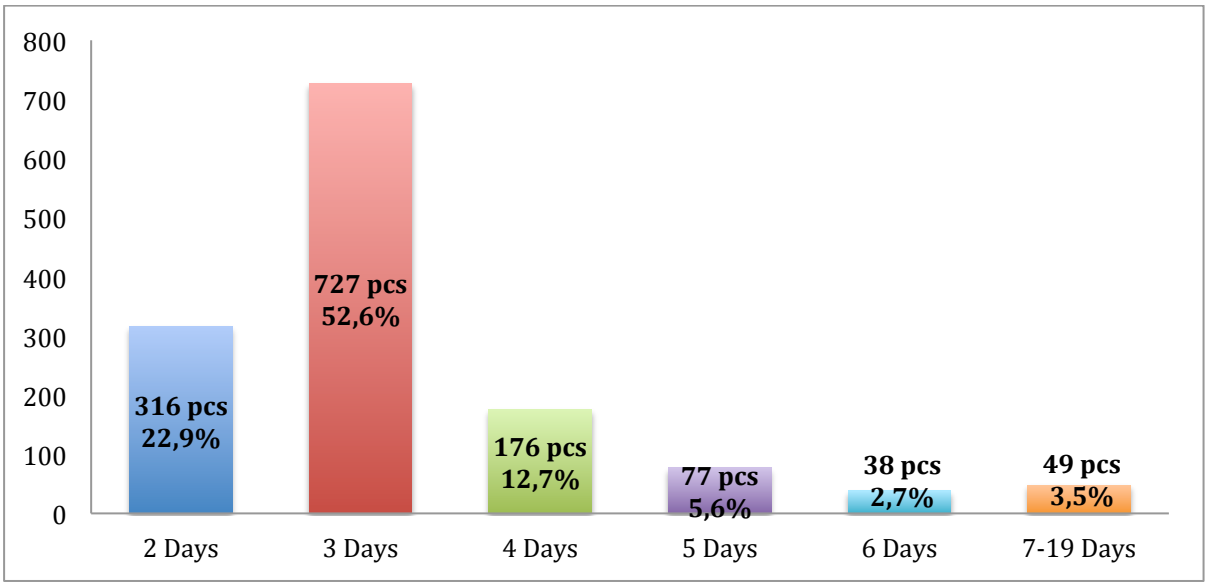

Figure 20: Lead-time from Plastal Raufoss to dealers connected to LDC Jönköping

4.5.4 Lead-time from Plastal Raufoss to dealers connected to LDC Gothenburg

Figure 21 shows the delivery time in working days from a dealer made an order of a bumper until it was received. A total of 2 814 bumper orders where identified to the dealers connected to LDC Gothenburg. At LDC Gothenburg a difference on the orders are made. For class 1 orders (total 28,5%), the bumpers left LDC Gothenburg in the morning with delivery same day it came in, while for Class 3 orders (total 71,5%), the bumpers left in the evening for delivery next working day. As seen in the picture, the time window for 3-6 working days (as promised by Volvo Sweden to the dealers) covers 96,7% of all orders.

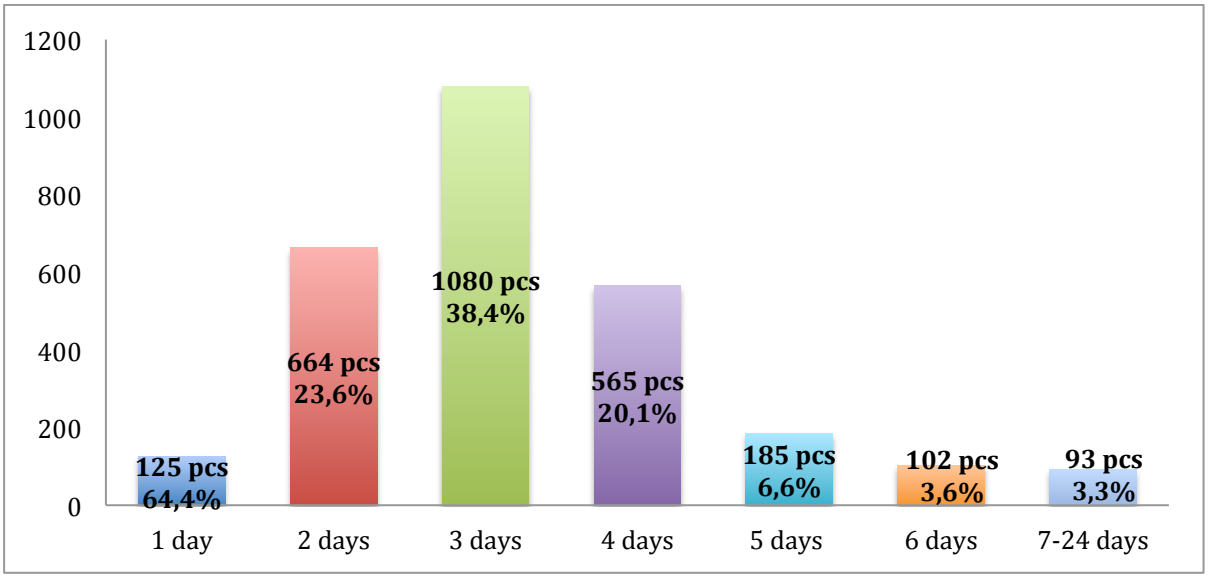

Figure 21: Lead time from Plastal Raufoss to dealers connected to LDC Gothenburg

4.5.5 Lead-time from Plastal Raufoss to dealers connected to LDC Örebro

In the case of LDC Örebro, a total amount of 2 106 bumpers where examined. At the LDC a distinction on class 1 & 3 is made, where class one stood for 31% of the total orders while class 3 covered 69%. A class 1 order leaves the LDC the same morning as it came in while a class 3 orders will leave with regular transport in the evening and will therefore be delivered to the dealer the morning after. 95,6% of all orders is covered within 3-6 working days to dealer. Summarize of all orders is shown in figure 22.

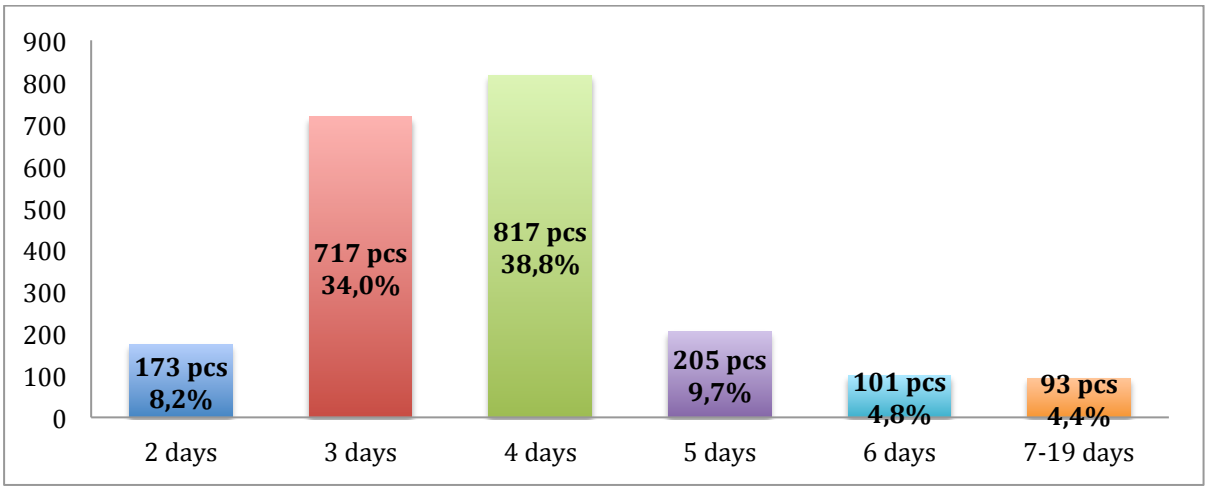

Figure 22: Lead time to Plastal Raufoss to dealers connected to LDC Örebro

4.5.6 Lead-time from Plastal Raufoss to dealers connected to LDC Stockholm

Order bumpers connected to LDC Stockholm where counted to 4 152 pieces and no differentiation is made whether the order is of class 1 or 3. In the figure 23 the lead times to the LDC Stockholm dealers is presented. 25 % of the orders where delivered within 2 working days and 97,4% of all orders before the 7th day.

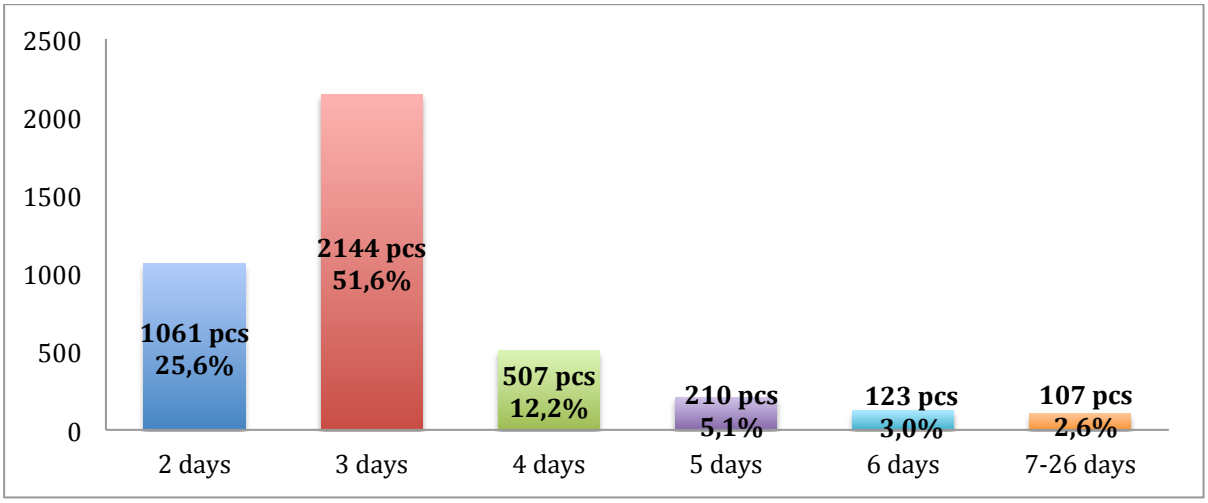

Figure 23: Lead-time from Plastal Raufoss to dealers connected to LDC Stockholm

4.5.7 Lead-time from Plastal Raufoss to dealers not connected to any LDC in Sweden

Figure 24 shows the delivery time in working days from a dealer not connected to a LCD made an order of a bumper until it was received. The bumpers arrived at a hub in Sundsvall, where they were distributed to the dealers. Total orders during the period were 1 096 pcs. For customers not connected to any LDC in Sweden, every order was treated the same way and there was no difference between class 1 and class 3 orders. However, there was a difference in where the dealers is located and due to distance from the hub in Sundsvall, 5 of 29 dealers had one extra working day added to the lead-time. As seen in the picture, the time window for 3-6 working days (as promised by Volvo Sweden to the dealers) covers 98,4% of all orders.

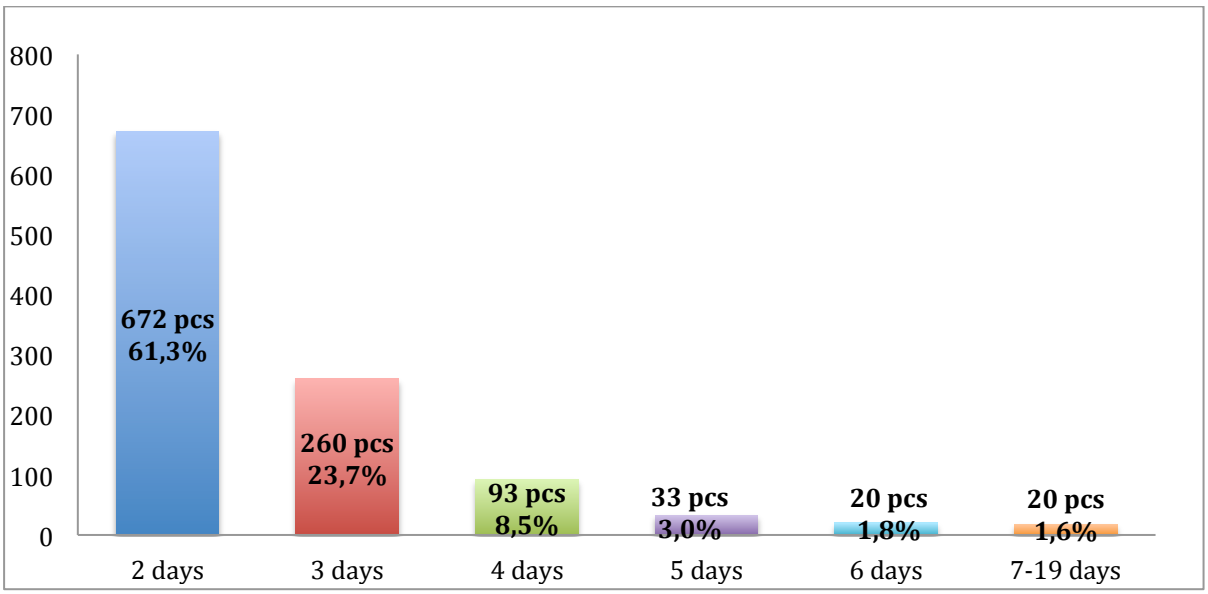

Figure 24: Lead-time from Plastal Raufoss to dealers not connected to any LDC in Sweden

4.5.8 Lead-time from Plastal Raufoss to dealers connected to any LDC in northern Germany

Figure 25 shows the delivery time, in working days, from a dealer made an order of a bumper until it was received at the dealers, connected to three different LDC in northern Germany. The LDC in northern Germany is located in Bremen, Hamburg and Hannover. The total amount of orders to LDC for the period in northern Germany was 2 204 bumpers. In this figure, no classifications between orders are made, only a summary of all orders from Plastal Raufoss to LDC. As seen in the picture, the time window for 3-6 working days (as promised by Swedish sales company to the dealers) covers 84,9 % of all orders.

The north German LDC's described above uses a transportation setup that transports the bumpers from the cross docking area in CDC to the LDC in Hamburg. The truck leaves CDC in the evening and arrives at Hamburg the following morning. From Hamburg distribution to Hamburg dealers and the LDC in Bremen and Hannover occur the following night. However, some special orders to the dealers connected to LDC Hamburg leaves the same day but in general bumpers is distributed further during night[11].

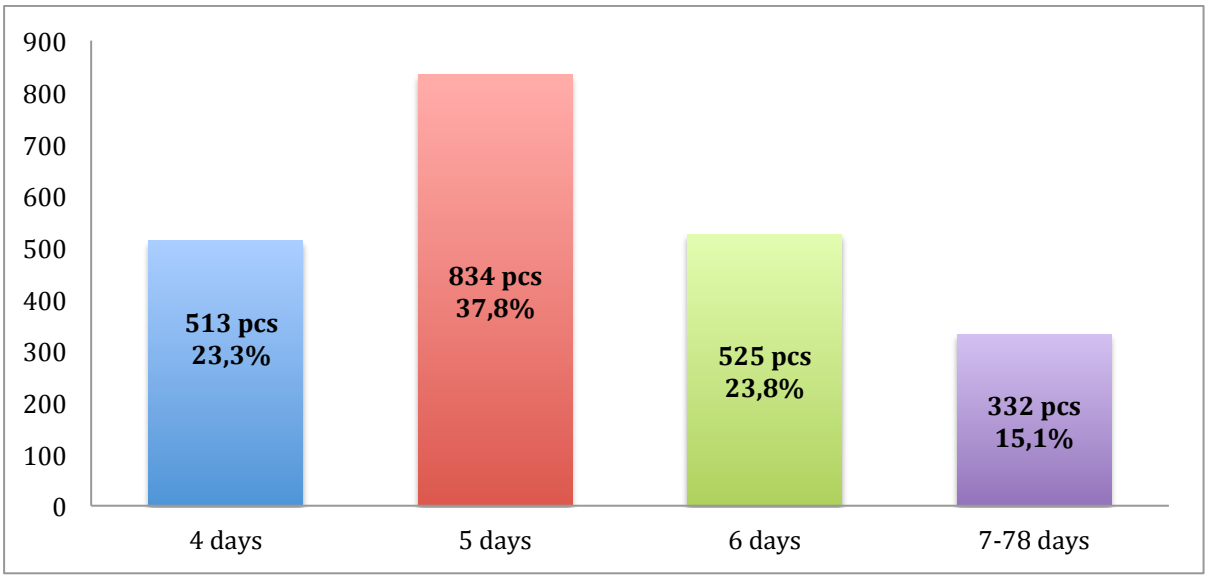

Figure 25: Lead time from Raufoss to dealers connected to LDC's in northern Germany

4.5.9 Lead-time from Plastal Raufoss to dealers connected to any LDC Bremen

Figure 26 shows the delivery time in working days from a dealer made an order of a bumper until arrival at the customers connected to LDC Bremen. The orders during time examined to LDC Bremen connected dealers were 386 pcs. In LCD Bremen, every order was treated the same way and there was no difference between class 1 and class 3 orders. 79,1% over the orders is covered within 3-6 working days.

The deliveries to LDC Bremen arrive the morning after they arrived at the LDC Hamburg. The dealers connected to Bremen all gets their painted bumpers over-night, meaning that they arrive at the dealer the morning after they arrived at the LDC.

[11] Cor van der Velden (Distribution Concept, VCCS Maastricht) interviewed 5th December 2013.

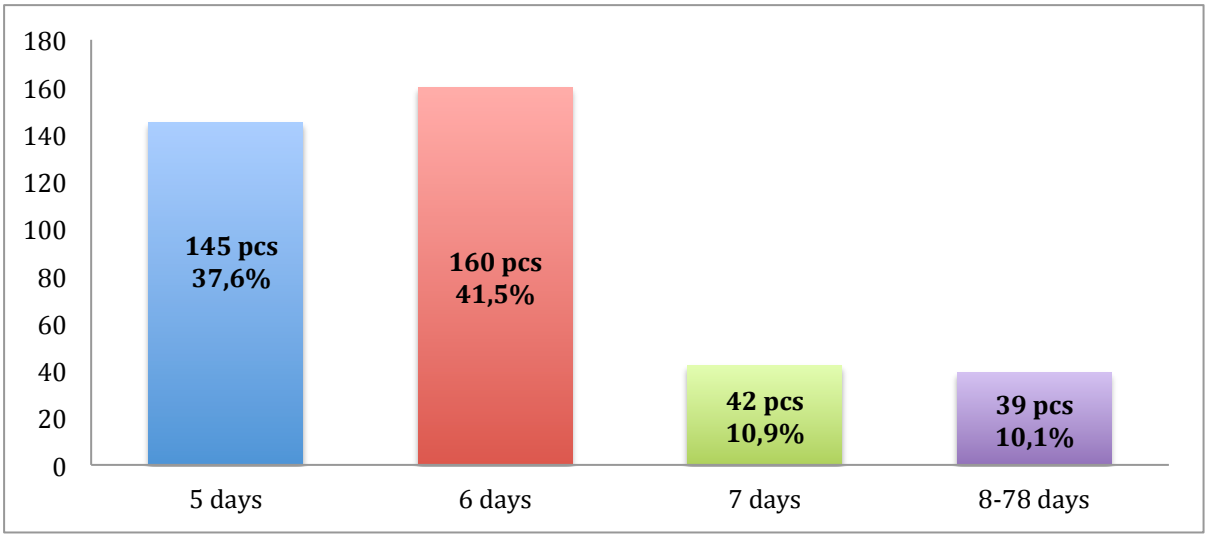

Figure 26: Lead time from Raufoss to dealers connected to LDC Bremen

4.5.10 Lead-time from Plastal Raufoss to dealers connected to any LDC Hamburg

Figure 27 shows the delivery time in working days from a dealer made an order of a bumper until arrival at the customers connected to LDC Hamburg. The orders during time examined to LDC Hamburg connected dealers were 1 167 pcs. In LCD Hamburg, every order was treated the same way and there was no difference between class 1 and class 3 orders. 89,8% over the orders is covered within 4-6 working days.

The deliveries to LDC Hamburg dealer occur the following evening (over-night) as they arrived at the LDC. Some special deliveries, when there is urgent need, gets bumpers during the day.

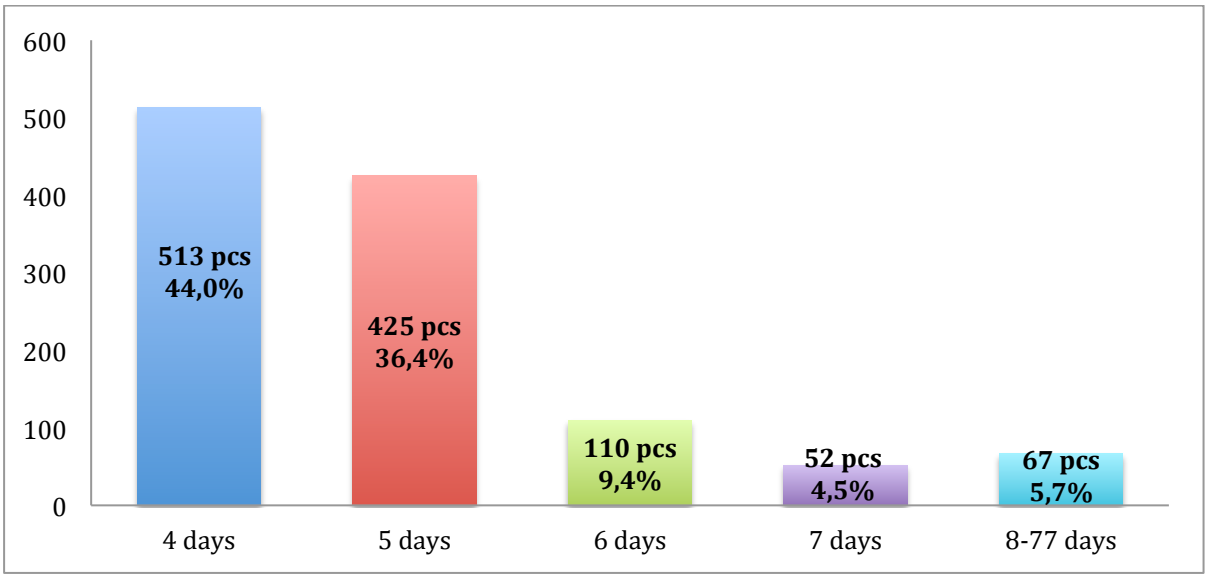

Figure 27: Lead time from Raufoss to dealers connected to LDC Hamburg

4.5.11 Lead-time from Plastal Raufoss to dealers connected to any LDC Hannover

Figure 28 shows the delivery time in working days from a dealer made an order of a bumper until arrival at the customers connected to LDC Hannover. The orders during time examined to LDC Hannover connected dealers were 651 pcs. In LCD Hannover, every order was treated the same way and there was no difference between class 1 and class 3 orders. 79,8% over the orders is covered within 4-6 working days.

For the Hannover connected dealers a distinction is made who states that dealers called *A-dealers* gets deliveries the same day as the bumpers arrive to the LDC while other dealers the transports occurs the following night and arrives at these dealers the following morning.

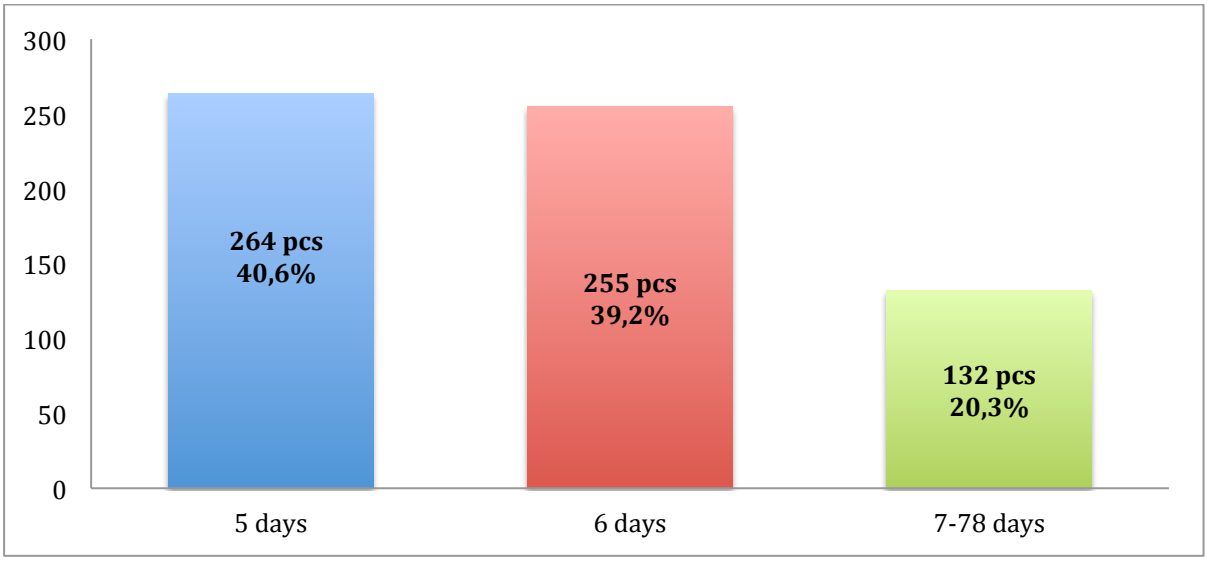

Figure 28:Lead time from Raufoss to dealers connected to LDC Hannover

4.6 Identified Problems

The empirical findings have given insight in the processes connected to the flow of painted bumpers. In this chapter we will present perceived issues with the flow based on our experience and information from different peers acting in connection to the flow. The issues are sometime similar in characteristics and do depend on each other at times, but in order for the reader to get a better overview we have tried to split the issues into suitable sections.

The empirical findings showed 10 main problems, summarized in table 12. These were divided into two problem related areas: IT-System and Organization and Management.

Table 12: Identified problems through the empirical findings

Company areas	**Problems**				
IT-System related	Order difficulties	Order Class variance	Delivery precision variance	Number of measuring points	Delay notification
Organisation and Management related	Overall responsibility	Increasing order flow	Quality issues	Return flow	Organisational structure

Order difficulties

When a dealer inserts the VIN (Volvo Identification Number) number and license plate number into VIDA (Vehicle Information & Diagnostics for Aftersales), the system will give a number of options available for the car and not the exact bumper needed for that car. For example, a V40 model year 2014, gives eight bumper possibilities ranging from only colored bumper, colored bumper with or without headlight cleaning, with our without park assist and then four alternatives relating to R-design[12]. The system gives the operator a wide option of bumpers to

[12] Patrik Sjöberg (Spare Parts Coordinator, Bilia Personbilar AB, Almedal) interviewed 6th December, 2013

order, from four up to twelve different bumpers types, depending on car model and production year.

Another example is the difficulties with ordering right bumper for bumpers with parking assist. Referring to the V40 model year 2014 again, there is two different parking assists that easily can be confused with each other. For all other car models, park assist referring to sensors in the front/back of the car that beeps when you get to close to an obstacle. But a V40 model year 2014 can also be equipped with park assist that helps the driver to parallel park, using radar sensors that are directed 90° from the side and thus have an extra hole drilled in the casing. These differences are not added into VIDA, which creates problems when the ordering is made.

To determine which bumper that fits the car, the repairman can either try to find what bumper that suits the car by using VIDAs car information page where it should be clearly described which parts the car is equipped with or by actually having the car in the workshop and check which setup the car is equipped with. Patrik continues saying that the car information in VIDA is not always clear on what version of bumper the repair shop should order and in order for the dealer to order correct bumper it thus relates to the experience of the repair man. The number of bumper variants for each car is broad and makes it complex to order the correct bumper. Determining the correct bumper is very confusing for the reseller and the reseller needs to have a great knowledge to order the right bumper out of 3.900 different bumpers available. Sometimes this occurs in that a wrong bumper is ordered, which then has to be returned to the supplier.

Another problem that indicates that something is wrong with the ordering process is that a dealer connected to the LDC concept are said to rather order two articles similar to each other if they are uncertain to which article that fits the car. Between weeks 1-40 in 2013, around 1 950 orders out of approximately 77 000 orders where returned to VCCS return code "Customer order by mistake".

The bumper is a big product in volume and the big amount of returns adds unnecessary handling and shipping to the already crowded supply chain. There are solutions of how to determine which bumpers to use, but the problem with using VIDA's car information page is that it takes a lot of time for the repairman to choose right bumpers. If the repairman doesn't know which bumper to order, he needs to see the car, which many times is not available when the bumper is ordered.

Order class variance

When a reseller makes an order for products that is not connected to the DDGS flow, they can specify both day and time during the day they want to receive the products. This option makes it much easier to plan activities along the supply chain. Depending on how quick the dealers wants the products, they choose between Class 1 and Class 3 orders. Class 1 orders are used when the product is needed the same day or the day after, while Class 3 orders are pre-planned orders, used when the dealer knows the day for a repair of a car. The dealers in Sweden are promoted to order both regular spare parts and bumpers with order class 3.

For the bumpers, the dealer can't decide when they want to receive the bumper. Instead the receiving date is determined by when the dealer makes an order. Table 13 shows the latest agreement between VCCS and Plastal for markets, order classes, cut-off times and shipping times for the bumpers.

Table 13: Markets, order class, cut-off time and shipping time for Nordic and Europe markets for Plastal Rau

Market	Order class	Cut-off time	Shipping time
Nordic markets	Class 1 and 2	Before 13:00, day 1	< 22:00, day 1
Nordic markets	Class 1 and 2	After 13:00, day 1	< 22:00, day 2
Nordic markets	Class 3 and 4	Before 13:00, day 1	< 22:00, day 2
Nordic markets	Class 3 and 4	After 13:00, day 1	< 22:00, day 3
Europe market	Class 1-4	Before 13:00, day 1	< 22:00, day 1
Europe market	Class 1-4	After 13:00, day 1	< 22:00, day 2
Europe, Maastricht	Class 4	Before 13:00, day 1	< 22:00, day 4
Europe, Maastricht	Class 4	After 13:00, day 1	< 22:00, day 5

Depending when a customer makes an order (cut-off time) the system is configured to determine when the bumper should be finished. But there is a problem with the system configuration, which creates difficulties in the planning process.

First, the shipping time for different order classes in the system do not match the agreement between VCCS and Plastal. Table 14 shows an order received by Plastal Raufoss going to a Swedish customer in the city of Staffanstorp. The order was made 30 Mars year 2011 at 17:30 with order Class 3. The order is a couple of years old, but the agreement is still valid. In this example, the LDC location is not important.

When looking at the latest agreements in table 13, it can be seen that a Class 3 order with a cut-off time after 13:00 day 1, should be delivered before 22:00 in day 2. If this was followed for every order, the order in table 14 should have a RFS date at 1 April 2011. But the RFS date is one day earlier, 31 Mars and this is not what the agreement said[13].

Table 14: A received order at Plastal Raufoss with date, time, order class and RFS date

Country	Customer location	Date when order was made	Time when order was made	Order Class	Ready for shipment date
Sweden	Staffanstorp	30 Mars, year 2011	17:30	3	31 mars, year 2011

Another problem in the planning process is that Plastal only looking at RFS date and doesn't care about if an order is Class 1 or Class 3. The system configuration makes it very difficult for Plastal to plan their production because the delivery date is based on when the order is received and not when the dealer actually wants the bumper. When a dealer make a Class 3 order, the dealer assumes that the bumper will arrive in 3-6 working days, which has been promised by VCCS. But for Plastal, the order class is irrelevant and the only important thing is that the bumper is finished before RFS date. If a Class 3 order enters the system before 13.00 day 0, the RFS date will be <22.00 day 1 and according to the lead-time calculation, the delivery to a LDC will be around 07:00 day 4. But if the bumper is needed in day 6, the bumper will be stored in stock and this creates costs.

[13] Henrik Dahlbom (Business Application Manager, Volvo Cars) interviewed 13th of December 2013.

Further problem with the configuration, which makes it hard to plan the production of bumpers, is that a Class 3 order can be produced before a Class 1 order, even if they enter the system the same day. For example, if a Class 3 order enters Plastal's system before 13:00 and a Class 1 order enters the system after 13:00 the same day, then the RFS date will be the same (see table 12). Therefore there are occasions when Plastal is producing Class 3 orders before Class 1 orders, even Class 1 orders are more important, at least for the dealers.

There can also be times when the same dealer makes two orders in one day, one Class 1 order and one Class 3 order. But if the Class 3 order is made before 13:00 and the Class 1 order is made after 13:00 then both these orders will have the same RFS. Since Plastal doesn't care about Class 1 and Class 3 order, it have happened that the Class 3 order has been finished and shipped to the dealer, while the Class 1 order has been delayed (due to production problems) and got another RFS day. The Class 3 order arrived first and was kept in stock, while the Class 1 order was delayed so the car couldn't be repaired, so the dealer had to pay for renting a car to the customer, while the customer had their own car at the workshop.

There can be occasions when only class 3 orders enter Plastal's system during a day. Then Plastal has to produce, paint and prepare them for shipping in the next two working day (depending on cut-off time), despite that the dealer will need the bumper two weeks ahead.

During 2013, the orders for Swedish dealers were split in 30 % class 1 and 64 % class 3. The issue is that close to 95 % of the orders to Plastal are treated as day order, which shall be shipped from Plastal with only 2 days margin (only to Swedish dealers). Plastal estimated that they have around 3000 incoming orders each week of bumpers[14], which close to 68 % of these are class 4. The majority of these orders is class 4 to Maastricht, as refill of stock, and shall be produced and shipped in 4 days. 81 % of total orders are marked class 3 or 4 while the Swedish dealers covers around 20 % of the total orders.

Delivery precision variance

46 % of the orders take three days from order to delivery to dealer connected to LDC while we have seen the deliveries can take between 1 up to 27 days. The variance of deliveries from Plastal is causing problems for the dealers, since they cannot know exactly when the bumper is arriving.

The problem with the bumpers is that they are not connected to the regular flow, which preventing the reseller to decide what day the bumper should be received. If the reseller decides to repair the car two weeks ahead and they order the bumper as a Class 3 order and all other products needed (for regular service) also as Class 3, the bumper arrives within 3-6 working days, while rest of the products arrives the time the reseller chose[4]. So the bumpers can arrive at the dealer five or six working days before the repair should be done, which creates unnecessary stock. One of the most important argument with introducing the LDC concept and different class orders was that dealers could avoid keeping products in stock to save money. Today's solution increases the stock, which runs counter with the LDC concept.

There are also differences in what promises Volvo Parts Sweden gives to the dealers and how the dealers perceive the promises. Volvo Parts Sweden has promised that a general delivery

[14] Kjell Olsen (Spare Parts coordinator, Plastal AS) interviewed 28th of October 2013.

lead-time is 4-6 working days, while the dealers says that they have been promised a delivery lead-time in 3-5 working days, but that the dealers themselves counts with 4-5 working days.[15] This creates problems for the dealers, because the variance in the delivery days makes it hard for them to plan their repairing dates. Usually the dealers are two-three weeks ahead in their planning (depending on size or the repair shop) and if they know that they will have to repair 15 cars in this interval, they can't order the bumpers due to lack of space. Instead they have to wait until some of the cars are repaired, but if the dealers have 10 cars one week to repair and they only can store 6-7 bumpers, there can be problems when they need the last bumpers. Especially if they use Class 1 order and the order gets RFS date the same date as a Class 3 order, then these orders will be delayed which cost extra money for renting a car to the customer.

The number of measuring points

To determine the lead-time through the supply chain, it is important to have measuring points so that the products can be followed in the flow. For the bumpers, there are three measuring points that makes it possible to follow when the bumper arrived at different locations. The first point is when a dealer makes an order, where time and dates is registered in the system and sent to Plastal. The second point occurs when the bumpers are scanned at the receiving area at LRN's terminal in Gothenburg. The third point is when the bumpers are scanned before leaving Volvo CDC cross-docking terminal. The current setup is illustrated in figure 30.

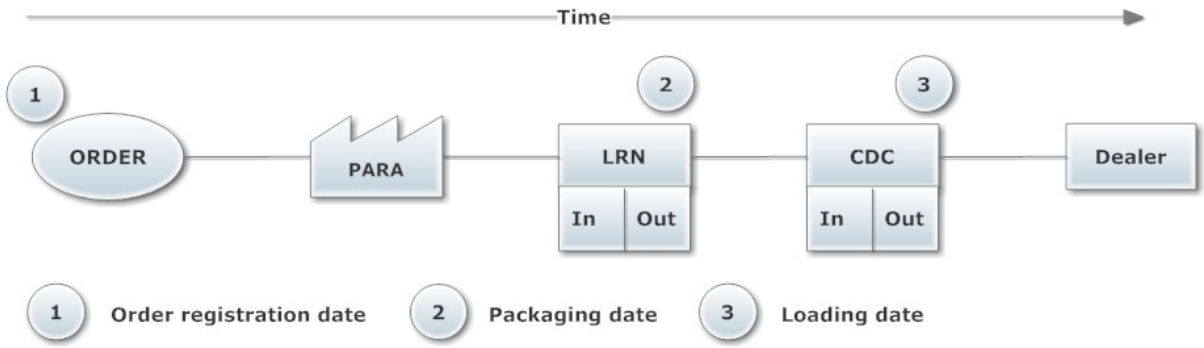

Figure 29: Measure point illustration of the bumper flow

After the cross docking at Volvo CDC, there are no more measuring points in the supply chain. For example, there is no scanning of the bumpers when the LDC's receives them, so neither the dealers, Volvo Parts Sweden or VCCS can follow the bumper in the supply chain after the bumpers leaving Volvo CDC. By not using any scanning at the LDC's it is impossible to clarify if a delay to a customer happened in any of the first measuring points or if the truck going from Volvo CDC to the LDC's was delayed or that the bumper remained at the LDC's. With the current solution, the arriving time for the bumpers are based on the agreed transport schedule, which of course can be wrong if something happens after the bumpers leaving Volvo CDC.

Delay notification

Plastal has since they implemented their new computer system in the early part of 2013 have had some implementation issues and some functions in the computer system works better than others. One of the functions that don't work satisfactory is a function giving an order a "this order is late" code, known as code 96. The idea behind the code 96 is that suppliers could mark an order with this code and give the order a new delivery date. Suppliers now and then run into

[15] Patrik Sjöberg (Spare Parts Coordinator, Bilia Personbilar AB, Almedal) interviewed december 6th, 2013

difficulties which unable them to finalize a particular order and with the 96 code, the supplier can tell the system that the order will be late and mark the order with a new delivery date so that the dealers can contact their customers and reschedule the repair or at least notify their customers. It is a ways of possessing the supply chain with accurate information of the orders and remove uncertainty in the supply chain.

The problems that Plastal has experienced with the coding is that they can mark an order with code 96 but the problem where that the order will be updated and marked with todays date instead of the real order registration day. It has been recognized during the master thesis that the problem is solved, but is has generated delivery precision figures for 2013 that do not meet their objectives.

Overall responsibility

The function group 8616 (painted bumpers) together with groups 8614 and 8619 (unpainted bumpers) is the function groups that cover the biggest sales for VCCS. These groups stand for about 4.0% of total sales around the globe. At the moment, the bumper assortment has no responsible person or group that can coordinate issues and future strategies with the assortment. Today's setup allow for several people getting involved into minor or larger issues and there is a risk of losing information as the communication occur in long paths as well as there is a conflict of interest as different people from various departments get involved.

Another issue regarding responsibility is that some years ago there was a so-called core team with persons from various departments during meetings discussing matters of the bumper assortment, but this team is no longer active. According to Plastal[4] they appreciated the core team since they could discuss issues regarding for instance technical questions with the team and enabling feedback between the supplier and the host company as well as with the customers.

Increasing order flow

The constant increase of orders to Plastal Raufoss generates both positive and negative effects. The positive thing is that the orders is increasing sale for the supply chain even further, while the negative consequences is that the plant needs to struggle even more to finalize the order in time, while the amount of article numbers is increasing continuously.

The increasing numbers or articles is a big issue for Plastal Raufoss, since the amount of phased out articles don't correspond to the increase of new ones, meaning that the range of articles constantly rises. Plastal Raufoss is facing lack of space in the factory for all the extrusion tools for producing the plastic bumpers. At the moment there is no clear strategy for clearing articles from the assortment. This of course is a challenging task since an article that is selling cannot be removed, but the question is how much time should pass after the last sale of a bumper, before the bumper is removed out of the article assortment.

Quality issues

One issue that was mentioned by Volvo Parts Sweden was the quality of the bumpers. They said that the paint job of the bumpers in general often was deficient. However, this is claimed to be a wrong statement according to the VCCS quality deparment. They states that the technical specification agreed with Plastal is met, but admits that in rare occasions the quality of the bumper isn't what it should be. When looking at the return codes used by the dealers and assuming that the return codes are used as instructed, only 11 % of the total amount of returned

bumpers in 2012 was because of damaged parts. The issues regarding the quality aspects of the bumpers are not major, but still high that it should be considered as a problem.

However, during the study we have seen that each and every part in the supply chain (stretching from Plastal Raufoss, transporter LRN, CDC personnel, LDC personnel and dealer) handles the bumpers incorrect; something that the quality department at VCCS encouraged us to look for. There are reasons for this mistreatment due to lack of space in storage facilities or lorries as well as the configuration of the packaging box (no sign with "this side up"). Even though it is not a major issue it should be accessed in the future.

Return flow

The return flow of the bumpers are today coordinated from Maastricht where all bumpers are collected. When dealers in the European market want to return a bumper, it is shipped to Maastricht who is responsible for the quality check. For the dealers in the Nordic market, the bumpers are shipped to Volvo CDC return department, but instead of making a quality check at Volvo CDC, the bumpers are collected at a assigned area and once a week the bumpers are shipped to Maastricht for quality check. Per Johansson, the manager at the return department at Volvo CDC, estimate the amount of bumpers for the Nordic market are around 30 bumpers per week. The amounts of returns where counted to around 3500 coloured bumpers during 2012.

When discussing the returns with Plastal Rausfoss, they said to be totally unaware of the amount of bumpers or what the problems with these returns were. There is no communication between Plastal Raufoss and Maastricht of what problems the quality department in Maastricht are facing and the insufficient feedback unable Plastal to improve their processes[16]. The transport from Volvo CDC to Maastricht seems to be unnecessary and creates extra transportation costs when the quality department in CDC possesses the knowledge to make the quality checks for customers in the Nordic markets. It has been told that the solution of shipping the bumper from Volvo CDC to Maastricht doesn't cost any extra money for VCCS since there is always a truck that goes from Volvo CDC to Maastricht once a week, but there is still a space needed for storing the bumper before the shipping, which could be used for other products when VCCS already has problem with lack of space in the Volvo CDC warehouse.

Organisational structure

The layout of Volvo Cars customer service is represented as a functional structure with departments divided into groups where each group represents a function in the company. Examples are purchasing, purchase planning, quality and construction. With these structures it often occur conflicts of interest between the departments. A typical conflict of interest could be the purchasing department seeking the lowest possible price on bought articles, which often imply requirements to large volume orders while purchase planning seeking decreased volume frequencies to lower the stock value and increase the warehouse space. In these contexts it is common to see that each department tries to optimize their own department and that a holistic perspective, the supply chain, is neglected. If each department seeks the best for the company and the supply chain, it might imply higher costs for a few departments, but the total cost for the supply chain or the company will be lowered and that flow in the supply chain can run smoother.

[16] Kjell Olsen (Spare Parts coordinator, Plastal AS) interviewed 28th of October 2013

5. Analysis

Through the empirical findings, ten main problems were identified. These problems were divided into two areas, *IT/System* related and *Organisation & Management* related where both of these affected the performance of Plastal Raufoss. Each of the areas had several problems of their own, but is to a large extent correlated to each other and cannot be viewed as isolated siloes. The lean philosophy actually states that in order to find the root cause it is very important to not solve the problems separately but in consideration of each other (Liker, 2004). To improve the overall performance of the Plastal Raufoss plant, it is important to take consideration into the two areas simultaneously.

Figure 31 illustrates that the two areas are connected with Plastal Raufoss overall performance. The organisation & management related issues, together with the IT/system related problems affects Plastal's overall performance.

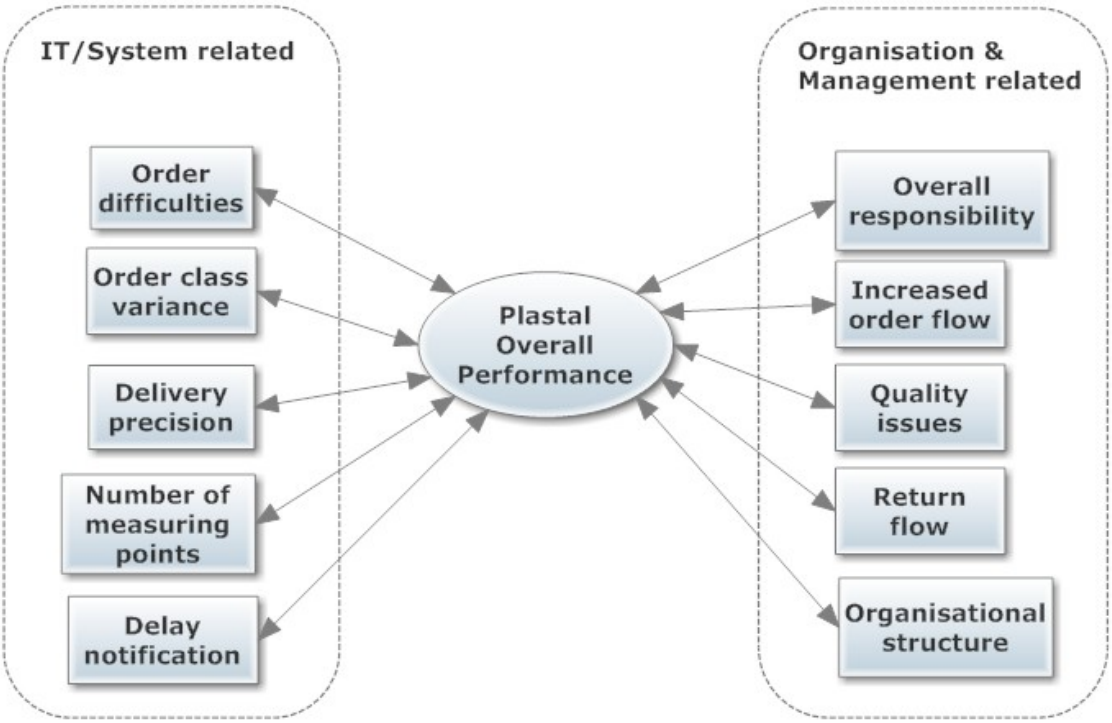

Figure 30: Issue relationship to Plastal's overall performance

Dealers had difficulties ordering correct bumper

The result when a dealer orders an incorrect bumper is that they send it back in accordance with the return policy. If it is a Swedish dealer, the bumper is first sent to CDC and then to Maastricht for regular quality check. This can be identified as two flows of unnecessary transports and is according to Liker (2004) one of eight non-value adding activities that should be removed. Even when transports are considered affordable, two flows that are completely unnecessary occurring in the chain results in costs. Thus, the dealer has to order a new bumper from the supplier who has produced two bumpers in total of which only one is needed.

The flows are a result of an information flow in the computer system that makes the dealer to order an incorrect bumper. An analogy to Liker (2004) where the author discusses overproduction can be drawn. The system had overproduction, which gives Plastal unnecessary high workload and the conditions for improving their performance is damaged.

Further, it is a result of an insufficient information chain where information about the complex ordering functions have been lost in the way to the IT department who are responsible for the ordering system. The interpretation is that due to the functional organisation structure, correct information about the complex ordering of bumpers has been lost passing through several actors in the chain. Foerstl et al, (2013) and Lambert et al, (2008) claims that functional coordination are important for the performance of an organisation, since companies often organise themselves as business functions where each function intends to optimise their own functions performance instead of focusing on the overall performance of the company.

Lambert et al, (2006) argues that companies must encourage cross-functional integration in order to gain efficiency in the supply chain. With cross-functional integration decision-making eases, especially in strategic level, and make the organisation more competitive (Kotabe and Murray, 2004). As the problem itself relates to IT-system and system configuration the problem occurred due to dysfunctional information coordination. This can be solved by involving a cross-functional team with interest in the bumper business, which task is to ensure full integration of the supply chain and its corresponding issues. The issue of the complex bumper ordering can be solved by blocking the number of alternatives that do not correspond to the original setup of the car or by specify clearly which bumper (and article number) the car originally where equipped with. The result will be lowered amount of orders by mistake as well as lowered costs of transportation, both in the direction towards Maastricht and in the direction from supplier to dealer.

Order class variance

Planning of the production schedule is of great importance for a company and should not be underestimated. Liker (2004) mentions that if a company can accumulate orders for a specified limited time frame and determine the pattern of the volumes and product mix, it is possible to plan a stable production schedule every day without major peaks or low utilization of the equipment and personnel. With this in mind it necessary to consider the problems for the order class variance in.

One of the major problems is that the agreement for the production schedule between VCCS and Plastal isn't connected with the same parameters in the IT-System. During the investigations, there has been times when orders has a RFS earlier then it supposed to, both for Class 1 and Class 3 orders. One interesting example was an order from Plastal Rausfoss, where a Class 3 order entered the system at 17:30, 30 Mars 2011(there hasn't been any changes in the system so the date is still valid). The RFS for this order was set to 31 mars 2011 <22:00. But table 12 indicates that a Class 3 order entering the system after 13:00 should be shipped in day 3 <22:00. This means that the actual RFS, according to the agreement, should be 1 April 2011. With orders getting earlier RFS time-windows than what is actually needed by the dealer, it is really hard to plan a stable production.

The setup creates problems for Plastal, especially if they only get Class 3 orders during a day. Then, depending on cut-off time, the bumper should leave the next working day or the day after that. If the system only gives RFS for the next working day, as it is today, all orders could be seen as only having one type of order class and then there is no reason of using different order classes. With todays setup it is also possible for a dealer to receive a Class 3 order before a Class 1 order, even if the orders enter the system the same day. This creates angriness with the dealers, with a lot of phone calls to Volvo Parts Sweden, which easily can be avoided.

Plastal doesn't care if an order is Class 1 or Class 3. This behaviour has to change in order for Plastal to easier plan their production. One solution is that Plastal starts to look at order class and produce Class 1 orders before Class 3 (and Class 4). There could also be a change in the system so the agreement between VCCS and Plastal is the same on paper as in the system meaning that if an order should have a RFS date in day 3 at <22:00, the RFS should not show a RFS date in day 2 at <22:00. Another solution could be that the time the dealer wants to have the bumper will be the RFS day and the system has to calculate backwards to get the exact RFS date.

According to VCCS, Plastal have had big issues with delivery problems during 2013. It is not strange that Plastal gets in trouble with their production planning with no stable production and big peaks, if they have to produce bumpers and ship them before they are needed by the dealers or that Class 1 orders get a lower priority due to a mistake in the programming of the computer system.

Delivery precision variance creates stock

The delivery precision during the examined period has had a remarkably spread in working days, with up to 27 days to delivery in certain cases. German LDC dealers where experiencing even greater delivery time on a small amount of their bumpers, close to 80 days. The really high delivery time is however rare and shows only one side of the spectrum.

The reasons for this delivery times are most likely due to machinery problem or similar at the Raufoss factory but the figure in between is more interesting. The main parts of the deliveries to Swedish LDC dealers, around 46 %, are delivered after three days but the range of the majority of the deliveries occur within 2-5 days. Regardless if the order is Class 1 or Class 3. The spread of deliveries makes it almost impossible for the dealer to order a bumper that is received just before the actual repair of the car, which is the aim with the LDC concept. Since dealers cannot predict the amount of delivery days they have to order the bumpers with a couple of day's margin in order to have the bumper when the repair is occurring. Meaning that the dealer will have to build a small stock of these articles, which are bulky items. Moreover, this is contradictive to the LDC concept, which signals that the dealer won't need a storage area. According to Liker (2004) this runs contradictive to one of the eight waste activities, excess inventory.

A regular flow within the LDC concept is based upon when the dealer want the articles and will serve the dealers up to three times a day in order for the dealers to remove all the inventory. The DDGS articles have a different setup, but still runs with the regular LDC flow due to transport efficiency reasons. The overall goal must be to integrate the DDGS flow into the LDC concept in order to fulfil the service offered to the dealers. Gunasekaran et. al. (2004) argues that customer value comes from providing the customer with a quality product, on-time and by providing a service system that respond to customer needs. Thus, todays bumper layout enables VCCS to provide a quality product, but cannot yet reach customer value since the product arrive unregularly and a service that not fully respond to the customer needs.

Instead, the ideal would be to always three or four working days in delivery for Class 1 and when the customer needs the product for Class 3. If one fully understands the transport time to each LDC and its dealers, the delivery day parameters in the system can be changed. This enables the dealer to request a delivery day for the class 3 bumpers of which the system count backwards, taken into account the delivery days parameters, to get a ready for shipment date

that is sent to Plastal. More than 60 % of order from Swedish customers is Class 3, which tells that the order is preplanned and not urgent. A change of this type will most likely result in that the majority of the Class 3 orders will give Plastal increased delivery time with these orders. Thus, Plastal will have increased capacity to deliver the urgent Class 1 orders first.

The number of measuring points

Competition in the automotive industry has been a constant high level with low margins as a characteristic for the branch. A strive towards increased profit is therefore a driving force. As a tool for increased margins organizations seeks control over its processes in order to remove unnecessary activities. Thus, measurement of the processes in the supply chain is highly relevant. Lynch & Cross (1991) claims that supply chain optimization come from activity efficiency. Arguments from Cooper & Fawcett (1998) states that proper use of performance measurement tools lead to better decisions in the supply chain.

The DDGS painted bumper flow has limited amount of measuring points, ranging from order registration until they leave CDC, which only covers more or less half the flow. When something occurs in the chain, VCCS won't be able to follow the flow and need to do an intensive investigation work in order to find out what happened. The control of the flow is in the hand of the operators, which is the transporters and the supplier. The metrics used to calculate the lead-time is not enough in order to capture the total flow and therefore the lead-time calculations presented in section 4.5 relates to the perception that the flow after the cross docking at CDC works without interruptions. Implementing any changes in the flow without proper decision support will not show the correct results of these changes as Gunasekaran et. al. (2004) where discussing.

In order for VCCS to control its supply chain it is essential to implement measuring points all over the chain. The figure 32 illustrating the flow of painted bumpers with implemented measuring points (number 4 and 5 in the figure). The implementation of the points will give VCCS the tools for controlling the supply chain, but there must be a system change in PULS to ease the performance measurement. Today PULS has the tools to analyze between point 1 and 3 but it is time-consuming and doesn't tell anything of the total lead-time. Increased number of measuring points will further imply that the performance of the supply chain will have trustworthy figures that can be used as decision support.

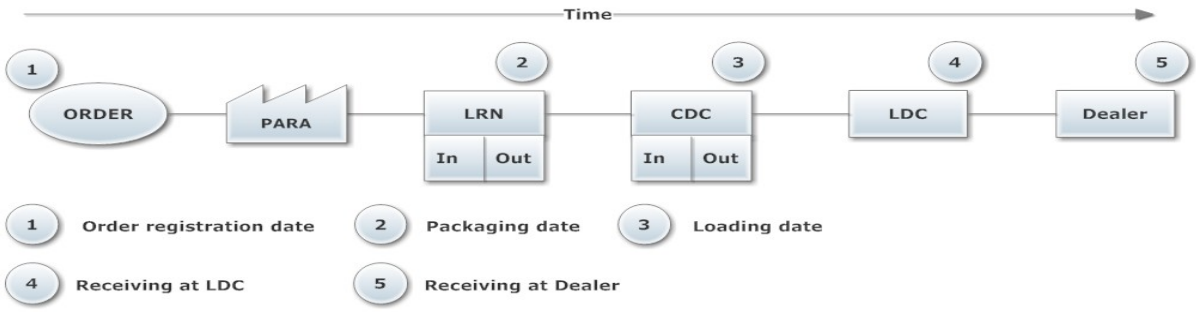

Figure 31: DDGS flow with increased measurement points

According to Volvo Parts Sweden short lead times is not a necessity. They claim that fairly good lead-time is enough if the dealers know what happens in the chain. Further, increased customer satisfaction can be achieved if the system enables the dealer's higher transparency of track and

trace of the ordered painted bumpers. This is achieved with a system change that enables the dealer to follow the orders in real life but more measure points need to be implemented first.

Delay notification

Customer satisfaction is the perceived value of a product for a customer. It contains both the product itself but also the service that the customer experience before, during and after the purchase. The customer satisfaction is affected of the product quality and the service offered. Meaning that a low quality product bought at a low price with low service level doesn't imply low customer satisfaction. A customer that purchase a product and is offered high service level in terms of different service function can be very satisfied with the product and will most likely purchase form that company again. The service offered affect the perceived value for the product and even if a delivery won't arrive at promised delivery date, the customer can be satisfied if he gets information about why and can plan for the late delivery.

The function of code 96 is a service offered by VCCS but in the case of the DDGS bumper flow operated by Plastal. The function gives the dealer information about a new delivery date if something occurred in the production process. During the examined time frame the function has not worked properly and has according to Volvo Parts Sweden raised angry customer queries. If the customers got information about disturbances they could plan for this and reschedule repairs of their cars[17]. Accurate information is therefore a necessity for the dealers and towards their clients. The customer satisfaction if something unplanned happens in the supply chain can therefore be high even though deliveries did not occur as promised. The code 96 is a service offered to the dealers in order to decrease the uncertainty and unnecessary work for involved actors in the supply chain and it is important that this function is used and running properly.

Overall responsibility

As it has been recognized in previous chapters, the painted bumpers stand for a major part of the total sales compared to other single product groups. If one includes the unpainted bumpers into these figures, no other product group at the moment stand for that amount of sales. However, there is no person or section within VCCS today that controls and regulates the business of the painted bumpers, which have been seen for other product groups within VCCS.

Van Weele (2005) highlights the importance of developing a supply strategy and states that without control of the supply chain, the power balance change in favor for the supplier who can use this in their favor. The lack of control in the DDGS bumper flow setup has enabled the supplier to have advantage over the supply and the focal company is basing their supplier performance evaluation on figures from the supplier. Further, the setup has been up and running for a long time and the focal company are trapped since there is no backup if the supplier runs into problems. The power balance should be shifter to equality or in favor for the buying company in order for them to control the chain.

Kraljic (1983) describes the issue of supply risk and implies that a buyer needs to secure long term availability for critical articles. In order to minimize the supply risk, one has to define the purchased goods in order to be able to bring accurate countermeasures if the supply is interrupted. Thus, by classifying the painter bumper product group, the importance of the product group will be stated and Volvo Cars can be able to focus on measures to control the flow in accurate manner.

[17] Seppo Lintanten (Product Manager, Volvo Cars Coperation), 2nd Okt 2013

The y-axis in the Kraljic segmentation model, figure 33, describes the profit impact on the procured goods. As mentioned earlier, painted bumpers are the function group that account for the highest sales which indicates that the profit impact is weighted towards high rather than low impact and thus belongs to the upper segment in the model. The x-axis describes supply risk. As the painted bumpers has a big variant flora and these imply complex production stages and the fact that the DDGS setup as it looks today makes Volvo Cars dependent on that the flow is running smooth and therefor the product is rather strategic (at the right hand side more than to the left in the figure) than leverage.

Figure 32: Kraljic segmentation model

Regarding the market analysis phase we can say that the capacity utilization of the supplier is overrepresented by VCCS orders, which also impact the annual volume purchased which is seen as high. What have been seen is that the demand is steadily increasing and there is therefore a dependent relationship between the buyer and the supplier.

In the purchasing portfolio matrix in phase 3 (see section 3.1), the company strengths are compared to supply market strength. As we are discussing big variant floras, a complex direct delivery setup and high demand the supply market strength is to be identified as low/medium, while the company strength should be seen as high/medium. Therefore, the matrix puts bumpers in the borderland of exploit and balance. Meaning that the supply risk is rather small and VCCS has to take advantage of the situation but not jeopardize the long-term relationship towards the supplier. They should not be to defensive, which Kraljic (1983) identify as over conservative and costly and thus a well-balanced intermediate strategy is preferred.

With the definition of the product clear, as a strategic product and a use of balanced to exploit strategy, a manager for the product group need to explore a scope of supply scenarios who acts as base for the securing of the long-term supply and by exploring short-term profit opportunities. However, there is no responsible group or a specific manager for the product group, which incur that the supplying company can exploit their situation and VCCS can risk of loosing potential revenue sources as the power now is found at the supplier.

The position of the supplier is in their favour and VCCS has no real countermeasures to use in order to change the power balance, which leaves the supplier at an exploitable position in the

Dutch windmill, figure 34.

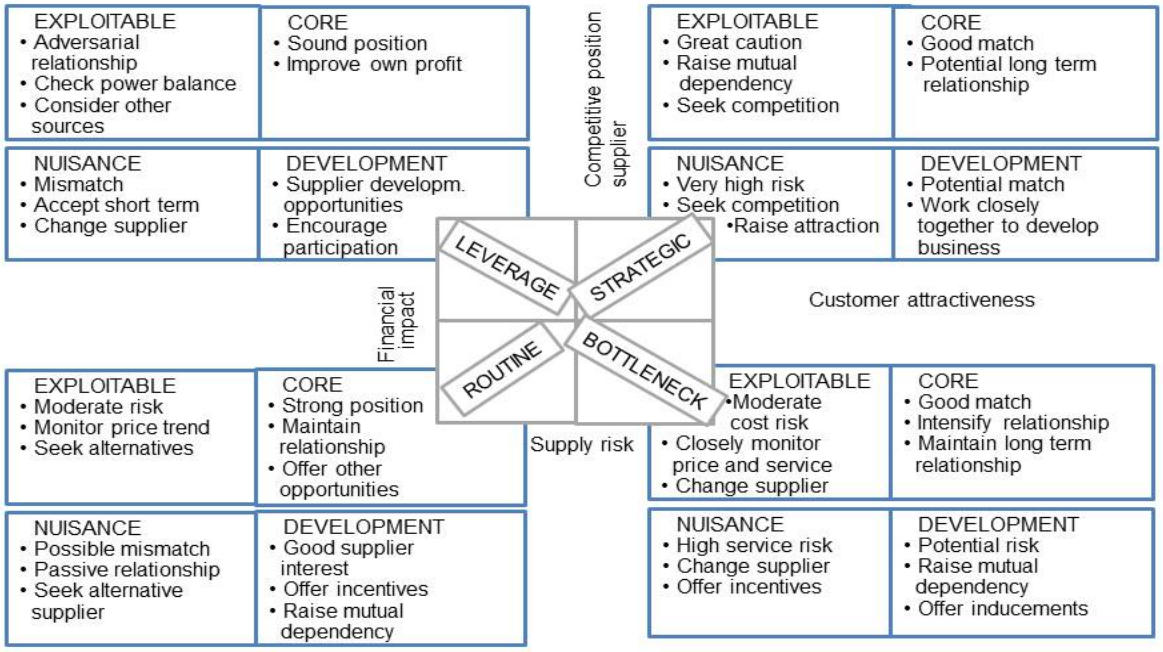

Figure 33: The Dutch Windmill

With further cooperation and at least equal power balance, the position of the supplier can move towards development or core, which will give both parties combined a strong profit impact and market position in the future.

Increasing order flow

The Plastal plant in Raufoss experiences a constant high workload and the order flow is steadily increasing. These are facts in general, but for some articles the order flow is rather low while for some others there is a constant high level of orders. It is positive since both the buyer and the supplier experience increased sales but a constant increase in orders will make it harder over time for the plant to be able to meet the demand.

The DDGS setup is configured with short lead-times and the effects when a process in the plant facing issues or when the demand reaches peak curves, the pressure on the plant is even bigger and the risk of not meeting the delivery time is big. The buyer rapidly intercepts when the supplier don't meet the demand and the dealers will have bear the effects of dissatisfied customers since they won't be able to process the damaged car due to the fact that the goods hasn't arrived. The LDC structure that is rolled out implies that each dealer shouldn't have any storage of goods and bring advantages in terms of less employed capital.

As a countermeasure to the peak of production a levelled schedule that constantly meets the customer need would be ideal. Liker (2004) argues that principle 4 in TPS illustrates the ideal production, where one constantly will meet the customer demand. This can be reached by examine the incoming order during a limited time and with this determine the patterns of the incoming orders and then create a schedule with even work load that meets the product mix and customer orders. However, a longer changeover time on certain machinery can drastically lower the effect of a levelled schedule. The idea of Heijunka is flexibility with even workload. Further, Liker (2004) states that meeting the customer need will in turn reduce the inventory over the supply chain. Thus, reducing capital employed. A demand peak will imply high workload on the

machinery and the employees. By extending the peak a company might run into big issues when machinery problems occur or the employees get injured due to the heavy workload.

Therefore, as Liker (2004) suggest in the principle of respecting your network of partners, cooperating in project with the supplier in order for them to bring down the changeover time on their heavy machinery and assist in the production planning in order to even the workload. There are gains to both parties, since the pressure on the supplier will be less if they can meet the customer orders in a preferred manner while for the buying company their customer satisfaction will rise if deliveries come more accurate. As Volvo Cars consider themselves a lean company this will encourage both parties to further cooperate in different issues.

The number of article variants is constantly increasing and makes the product range even bigger for the supplying company. While they experience increased variant flora issues rise since the amount of tools needed for each model is increasing and these tools are big both in volume and weight. If the parties can cooperate with the production, the proposal is as well to discuss the amount of articles and agree upon issues referring to the amount of variants. An idea is to reduce the number of painted bumpers that sell in low quantities and only sell these in black and let the paintjob be done locally at each dealer.

Return flow & Quality issues

The return flow of painted bumpers is coordinated from Maastricht, but with a buffer station at the CDC Gothenburg for the Nordic returns. In Maastricht all the returns are checked according to a quality check scheme. However, it has been experienced that Plastal doesn't get any feedback from the return department and thus cannot be aware of any potential lack of quality if they do not find quality issues inside their production. The communication as of today between these parties is insufficient. Liker (2004) discusses Toyota as a Learning enterprise, meaning that the supplier and buyer are learning together. Even though VCCS are working with a lean transformation, the transformation has either not reached Maastricht or the quality department in Maastricht has no routine of communicate issues with Plastal. Principle 11 according to Liker (2004) refers to develop the network of suppliers but without feedback the suppliers will face issues of fixing quality problems that may be present in their processes.

Liker (2004) experienced the typical example of principle 11, respecting your partners, when a supplier in US faced quality issues. Toyota directly sent representatives in order for them to help the supplier to fix the issues and help them develop. A lean enterprise build a culture to assist when facing problems and by assure the quality in the chain a company will eventually remove the quality department. The principle 5 according to Liker (2004) explains a philosophy of finding problems and seeking their root cause as they appear. The non-feedback existing culture in Maastricht won't enable the flow to find and fix the problems as they occur.

An analogy to principle 2 in TPS is that inefficiencies is now hidden in the processes where buffer inventories are to be found in CDC Gothenburg for the Nordic returns as well as in Maastricht where they buffer quality issued articles for the quality control. Defects is one of the eight non value adding activities that Liker (2004) states has to be removed because it doesn't add value to the customer, instead it acts against the customers and the customer value is lowered. Volvo Parts Sweden complained the quality issues as something they regularly were to be discussed with their dealers. They claim that the paintjob on the bumpers are insufficient and during 2012 it was identified that 11 % of the returns was issued as damaged parts.

Included in the non-value adding activities identified by Liker (2004) is the unnecessary transport. Same author implies that all of these activities should be removed. Some transport will be necessary but in the case of the return flow, transports to Maastricht could not be seen as a value adding activity and should therefore be removed in the long run.

As an identified problem, handling issues is in the chain, each part in the chain handled the bumpers carelessly and this is of course something that will affect the perception of the quality at the dealer. Damaged packaging will affect how well the products can withstand external force.

With these issues identified the transports should be removed in the long run but to start securing that quality issues don't occur regularly these transport will be lowered. A suggestion is that the quality check at Maastricht regularly sends feedback to the production plant in order for them to visualize and develop prevention processes. The handling issues needs to be complained at the activities that occur in the chain in order to improve the processes. As the handling seems to be activity that is difficult to hinder, this can imply that development of new packaging and transportation materials that secure the quality of the goods during handling and transportation needs to be launched.

Organisational structure

As the structure of VCCS is based as a functionality approach, conflicts of interest often occur between departments. It has been experienced that departments easily state that this issue relates to another department. If the issue relates to another department it is highly important to make sure that this particular department is getting the complete insight in the issue, but the behaviour implies risks of losing information along the way to the complained department. The worst case scenario is that the information doesn't even reach the concerned department. Lambert et. al. (2006) lightens the issue meaning that the individual functions mustn't protect themselves in order to get efficiency in a supply chain. Hosang and Bongju (2005) has identified that common mistakes in companies is that individual functions tries to minimize their own costs and do not consider the holistic perspective of the company or the supply chain. They think that a reason for this behaviour can be the budget restrictions set by top management. Plastal discussed that when they experienced issues, both technical and economic related, they had difficulties to reach the corresponding function or person within the VCCS to discuss their matters.

The functionality structure can damage a relationship or hardens communication or problem discussions between buyer and supplier. Liker (2004) interpret that supporting suppliers with issues regarding i.e. technical or human resource matters will cure suppliers from sickness in a holistic way.

Mentzer et al. (2008) argues that individual functions within a company are dependent on each other in order for the supply chain to work efficient. However, their interpretation is that each function needs its own functional space but with an overlap of other functions. A cross-functional approach could therefore be necessities to support and perform different supply chain strategies. Daspit et.al. (2013) claiming that using cross-functional teams can be an effective tool to make changes in organisations. Kotabe and Murray (2004) support this and meaning that integration of functions can make a firm more competitive. However, there are negative critique stated by Majchrzak et al. (2011) saying that cross functional groups can imply communication barriers between members in the group and can result in conflicts between

departments.

As a solution to the issues relating to the structure of the organisation, taken into consideration the risk of creating conflicts between departments a compromise in the way of introducing a core team acting only with the DDGS painted bumpers segment, including functions from i.e.; purchase planning, purchasing, quality and construction. Thus, you will introduce cross-functional integration in minor scale that can support Plastal in their matters relating to different areas, but also ease communication and speed of issue solving in order to increase the efficiency of the supply chain. Further, the core team components can also exchange experiences relating to their respective function, which hopefully result in better understanding of how a decision can affect the complete supply chain in a positive or negative way.

5.1 Performance measurement suggestions

The following section will present suggestions for measuring the efficiency of the bumper flow. The metrics can also be modified to fit into other product groups. The proposals are based on the authors' view that the KPI:s that exists is used in small extent or that they do not even exist in the existing flow. The perception of the suggested metrics is that these offer the lowest opportunity for manipulation.

Gunasekaran et.al. (2004) thinks that producing value for the customer root in maintaining the customer satisfaction with a flexible service system that is designed to meet the customer needs. This is achieved by providing accurate customer query time to the customer and offers him a quality product that meets the query time, meaning that communicate an exact delivery day and a delivery that meets the told delivery day with a damage free product. The authors argue that supply chain performance can be improved when there is control of the processes within the chain. To reach supply chain optimization efficiency and effectiveness of each activity and actor in the chain is essential meaning that you seek control of the processes in the chain. Using measurement systems in the supply chain will help the organization to see effects of changes and will assist in the organisations strive towards control. Lynch & Cross (1991) claims that control of the activities in the chain gives efficiency. In order to control a chains activities one has to measure its performance now and after implemented changes. Further, measurements will help the organization to find activities that work inefficient.

What to measure

- Order lead-time: A measurement from the order registration time until it is delivered at the customer, the dealer. Reaches its full potential when there is a measuring point at the unloading area at the dealer. Today's setup only enables to measure from order registration until it leaves CDC and after that one have to make estimations on what time the transport to the dealer should take.
- The customer order path describing the path of the order. Can for instance be used to investigate where the products during the flow is stored the longest. Available only when there is measuring points at the unloading area of the LDC's and at the dealer.
- Supply link evaluation at operational level: Measuring the adherence to agreed delivery schedule, also known as delivery precision or on-time delivery (Compare order registration date to the number of days the delivery occupy, in the normal case, to each LDC). An alternative when you have a measure point at the end customer one could compare the order registration date to when the repairing of the car is planned and see if the lead times correspond to agreed lead time. What one can do today is to measure the

supplier delivery performance by measure the time in-between order registration date and when the goods leave LRN terminal, these points are already set in the system. Further it would be interesting to measure number of complaints and which of those who were correct/incorrect, this requires feedback from the quality checking section but by controlling the quality on the product can lead to cost reduction and sending feedback to the supplier will increase the quality of the products.

- As a financial measure it would be interesting to measure the product range profitability; meaning that you investigate the cost and profitability (margin) as well as number of units sold of the number of articles in a specific product group. This can be used in order to decide whether an article should be withdrawn from the standard assortment or not. Figures are already available in the main enterprise system but it requires some data handling. Further financial measurement, which will imply the complete company, not only VCCS, is to measure the cost of backorder. A backorder can generate a lot of both indirect and direct cost and this measure will demonstrate the importance of on time delivery. For instance direct cost include rental car to the customer for the sales company while indirect costs are the time spent for several actors in the chain to solve the issue.

In the table 16, a summary of suggestion of KPI is presented in order to measure the supply chain. Short term column represents metrics that can be implemented, or measured, today while the long term column represents those KPI's that require some adjustments in order to be measuring correct, such as more measuring points in the flow. The supplier delivery performance and the delivery performance are similar in their characteristics but the width of what they measure is different.

Table 15: Suggestion of KPI's

Short term	Long term
Supplier delivery performance	**Order lead-time**
Number of complaints	**Customer order path**
Product range profitability	**Delivery precision**
Cost of backorder	

6. Conclusions

Even though each identified issue, relating to either IT/system or Organisation & Management, has been seen as an issue separated from the other it exists a clear relationship between the issues. Trying to solve the issues separately is possible, but will lead the problem solver into other issues due to the existing connections. Therefore a supply chain perspective of issue solving would be necessary in order to improve the overall performance of the chain.

Regarding the lead-time, it can be said that most of the shipments are delivered within the time-windows of 3-6 working days. For the Swedish customers, 96,6% of all orders arrives within the time-window, where the percentages are set to be 95%. This is a very good figure, but there have been situations when the lead-time took up to 27 working days and it is of course not so strange the customers are raising their voices when they have to wait so long for their bumpers. Though, it is still a very good number for Plastal to deliver so fast, which indicates that the delivery time isn't that important issues as it was thought from the beginning. For the German customers, the delivery time is only 84,4%. The reason to this might be the long travelling time from leaving Volvo CDC until the bumper arrives at the German LDC's, since it takes up to two days to deliver the bumpers with the milk runs. It should be stated once again that the total lead-time is based on interviews and observations, with expectations that a bumper always was delivered within the time-windows for leaving Volvo CDC and leaving the different LDC's and that our calculations for these might be wrong.

The complex routine of ordering bumpers has led to flows of unnecessary transports, both in the direction to Maastricht in terms of returns but also in the direction to customers at first hand. If a bumper is ordered wrongly, Plastal has to produce products that aren't needed in the end of the chain leading to higher workload than necessary as well as in terms of use of resources. A high workload over time can result in missed deadlines and for VCCS the customer satisfaction will decline. The communication issues between Plastal and Maastricht relates to the difficulties for the supplier to fix perceived quality issues which results in decreasing customer value.

Further, issues relating to order class links to prioritisation misfit and a system that don't support the supplier and enables unnecessary stress in production with a result of lower delivery precision to the customer. The lack of measuring points doesn't only hit the possibility for measuring the supply chain, it also results in decreased customer satisfaction when dealers cannot follow the deliveries or ask Volvo representatives about it because it is difficult following the orders as they flows through the chain. The results of an incomplete programmed *late delivery* function, code 96 and increase the uncertainty for the actors in the chain. A lack of responsibility function controlling and assisting the supplier results in further uncertainty and increased problem solving time and will damage the overall performance of the supplier, a risk of losing potential revenue increase as well as lowering the customer service. Better communication at higher level can increase strategic decision-making in terms of for instance declining article assortment.

As suggestion for improving the supply chain efficiency, the cooperation between VCCS and Plastal and to enable a smooth DDGS flow of bumpers, there are three solutions that can increase the efficiency if they are implemented, where these should be implemented in parallel where one covering a longer time frame.

- In order to increase the transparency along the chain and enable for reliable performance measurement one **has to implement measuring points all over the chain**, preferably at the LDC and at the delivery at each dealer. This is illustrated in figure 25 in section 4.6. With more measuring points VCCS can determine the exact lead-time in the whole chain, including transport times and can avoid time-consuming lead-time calculation.
- If **enabling the dealer to order Class 3 bumpers according to when they will actually need the product**, the transport time can be used as a tool for calculating the ready for shipment date that is sent to the supplier. This is a future scenario that is resource friendly towards the whole chain and will give the supplier a lower workload than today and therefore has a better possibility to complete all orders within deadline, ready for shipment date, but also to plan the production much easier. If the bumper can arrive more closer to when they are needed, the storages of bumpers can be reduced.
- Todays' setup is operated without total control and the DDGS flow runs for itself. The lead-times are decided at one way in the system and communicated lead-times are roughly corresponding to the actual lead-time. The suggestion, which spread over longer time frame, is the one **involving a cross-functional core team** whose aim should be to support and control the painted bumper flow. The work of a cross-functional core team will be to assist the supplier with production issues or other technical issues as well as coordinating the flow to increase the customer value and explore potential sources of revenue. The overall goal must be to integrate the DDGS flow into the existing LDC concept, which further will increase offered service to the dealers.

7. Discussion

In the planning and setup process of the thesis we identified research questions in order for us to keep the focus on relevant information and they also assisted when concluding the thesis. However, the questions haven't been used in order for us to clearly state the answer to each of these questions due to the relationship between them. Instead they are answered as bottom line questions and are embedded in the thesis in order for the reader to experience a smoother flow in the reading. To give an example the *RQ1: "How do the current situation and setup of the bumper flow look like?"* and its sub question "*How is the flow controlled and monitored today?"* are described in the empirical findings chapter while *RQ2: "How can the lead-time to customer be more precise?"* are described in the analysis of the identified problems and one of its corresponding sub questions "*What is the current lead-time to markets?"* are answered in the empirical findings section.

Regarding the works owner, VCCS, we can say that their progress into efficient logistic systems are constantly developed and the fact that only choosing to do an investigation covering the processes related to the painted bumper flow shows that they are aware of their issues and intends to develop its own supply chain efficiency further.

A short remark to the relation to Toyota Production System is that just using parts of their production system or even only some tools would not give a satisfying result. A justification of why Lean is considered important in the thesis is that Volvo Cars are working with their own production system with ingredients from Toyota's production system.

8. Further research

As the work is covering the painted bumper flow and its processes, a further research could touch the different ends of the supply chain; the customer side with their perceived issues relating to the bumper flow or the supplier side covering organizational- and production related structure and their impact on the system itself. For the university relating studies, an investigation in the overall layout of direct deliveries with this flow and the total economy with its hidden costs, or direct costs regarding transports, versus customer service would be interesting.

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Appendix A

Person	Responsibility
Li Norrby	Group leader Purchase Planning VCCS
Henrik Dahlbom	Business Application Manager, VCCS
Kjell Nilsson	Purchase Planner, VCCS
Sandra Johanesson	Purchase Planner, VCCS
Kjell Olsen	Spare Parts coordinator, Plastal AS
Anders Larsson	Distribution Concept, VCCS
Annika Forslund	Dealer support Order & Delivery, Volvo Cars Corporation
Seppo Lintanten	Product Manager, Volvo Cars Corporation
Karin Nikolouzos	Volvo Parts Supply & Logistics
Nicklas Andersson	Production Supervisor Logistics, Plastal Gothenburg
Toumo Saaranen	Inventory Manager, VCCS
Mikael Möller	Logistics coordinator, PostNord Logistics AB
Cor van der Velden	Distribution Concept, VCCS (Maastricht)
Patrik Sjöberg	Spare Parts Coordinator, Bilia Personbilar AB, Almedal
Peter Byvik	Quality department, VCCS
Per Johansson	Manager Return department, VCCS
Anders Södergren	Spare Parts manager, Bra Bil Stig Center, Göteborg
Olle Zetterquist	Transport Purchaser, Parts Supply & Logistics, VCCS
Bengt Tilly	Spare Parts manager, Bilia Personbilar AB, Almedal
Martin Thomasson	LRN Transport AB
Ingemar Spång	Manager, LDC Gothenburg
Anders Göthensten	VCC IT