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Exploring Lean Principles in Automotive Aftermarket for Spare Parts Distribution: A Case Study at Volvo Parts

Master of Science Thesis in Supply Chain Management

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Abstract

Aftermarket, as one of the main profit generators for the companies, has gained increasing attention recently. Therefore, companies are always seeking for new methods and solutions enabling them to provide the best possible service to the customers through the most efficient ways. In this trend, companies operating in the automotive industry are no exceptions.

Looking through the long history of lean in automotive industry and its proven success in different contexts remains no surprise to see companies using lean principles in the aftermarket. This fact perfectly motivates the endeavors of Volvo Group, a world leading automotive company, to achieve the best position in the aftermarket.

The purpose of this thesis, hence, is to investigate the challenges and opportunities of Volvo Parts, a business unit within Volvo Group managing the aftermarket, in applying lean principles. The thesis has been conducted through a qualitative study including literature study as well as investigation in different Volvo Parts areas, namely, sourcing of parts, warehousing and distribution.

The main framework for the study consists of investigations in aftermarket industry and its characteristic, lean principles and its application in the aftermarket and Volvo Parts' specific situation in the aftermarket.

The analysis concludes that improvements within Volvo Parts should be focused on all three main areas; managerial, tactical and operational. The main recommendations for Volvo Parts to ensure the improvements include: establishing metrics which are in line with the overall goal of the company, i.e. availability at the customers, preventing sub-optimizations in the departments by moving towards more process-oriented organization, standardizing the activities through stabilizing the lead-time, providing proactive approach to the problems and motivating this culture in the organization, looking upon the inventory as a necessary part of the supply chain to satisfy end-customers and establishing incentives to support the availability of parts where they are needed.

Key words: Automotive aftermarket, Lean warehousing, Lean distribution

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Göteborg, June, 2011

Fatemeh Ehsanifar Rasmus Rubin

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List of Abbreviations

Abbreviation	Explanation
ASN	Advanced Shipping Notice
DIM	Dealer Inventory Management
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
ETA	Estimated Time of Availability
FTL	Full Truck Load
JIT	Just in Time
KPI	Key Performance Indicators
LPA	Logistic Partnership Agreement
MM	Material Management
ODM	Order and Distribution Management
POL	Parts OnLine
ROP	Reorder Point
SKU	Stock Keeping Unit
TPS	Toyota Production System
VIPS	Volvo Importer Partner Service
VMI	Vendor Managed Inventory
VOR	Vehicle Off Road (an order classification given the highest priority)
VSM	Value Stream Mapping
VP	Volvo Parts
VPS	Volvo Production System
VV	Volvo Vision
WIP	Work in Progress
WM	Warehouse Management

1. Introduction

The aim of this initial chapter is to provide a brief description of the master's thesis and the background of Volvo Parts (VP). The introduction starts with the background of the thesis in order to explain Volvo Part's interest in lean thinking and its motivation towards the deployment of the lean principles in different operations in the company. The background is followed by the purpose, the research questions and delimitation of the thesis.

1.1 Background

The role of providing solutions and services to the aftermarket has become more central in the automotive industry and the value and profit created in aftermarket services has grown (Cohen, Agrawal and Agrawal 2006). This is in line with providing service and support solutions during a product's life time. The aftermarket value and solutions stems from the organizations' awareness of customers´ expectations and needs which put pressure on them to focus their resources to these needs and expectations.

VP is a business unit within Volvo Group. The unit is the aftermarket solution provider for Volvo Group and its seven business segments (Trucks, Buses, Construction, Penta, Renault trucks, Mack trucks and UD trucks). The company's three major operation areas are: parts logistics, product support development, and customer support. The parts logistics is an important area in which Volvo is responsible of the whole supply chain from product out to the customer and therefore put resources to uphold responsiveness to create customer satisfaction.

In the annual report of the year (2010), AB Volvo describe their three main strategic objectives; profitable growth, internal efficiency and product renewal. Out of these three, Volvo Group clearly states that a special focus will be on the internal efficiency and product renewal objectives. These objectives point out the strategic direction of the business segments and units for a period of two years. It also describes the need for the establishment of best practices in the organisation to decrease costs both on a regional and global level. This further motivates the initiation of several parallel projects within the company.

1.2 Problem Discussion

As mentioned earlier, VP is an organization which provides aftermarket solutions for Volvo Group. The strategic direction is to provide valuable solutions for the organization to develop and adapt to the changing needs and expectations from the customers. To respond to these objectives and fulfil them the organization wants to investigate the use of lean principles in the value stream for spare part distribution.

The initiation of lean thinking in VP is partly related to the variant reports of lean success in other organizations (Liker 2004, Womack and Jones 2003) and partly the result of Volvo Group's strategy towards lean which shows itself in terms of the Volvo Production System (VPS). VPS which is an adapted version of the Toyota Production System (TPS), deals with the implementation of lean in the Volvo Group's production supply chain. The VPS main focus starts by investigation of lean philosophy in the company from a strategic perspective followed by the smaller targets and projects on tactical and operational levels. The main covered areas in VPS are: the Volvo way (consisting of leadership, safety and health and environmental care), team work, process stability, just-in-time (JIT), built-in quality and continuous improvement.

The starting point of using lean principles in VP aftermarket can be traced back to the warehouse operation. The central warehouse in Lyon introduced lean thinking in their operation and faced some serious problems. While the performance of the warehouse as an individual part of the supply chain has shown improvements, Lyon warehouse has experienced difficulties in interaction and collaboration with the other parties in the supply chain. The experience was that the different actors made improvement in isolation with little consideration to the effect for the other operations. It therefore only served the goal and performance of one individual part in the supply chain instead of understanding the whole value stream. Another area was the difficulties to find forums to share knowledge and improve the processes and activities in coordination.

The involved parties in VP internal supply chain are material management (MM), warehouse management (WM) and order and distribution management (ODM). These three departments are responsible for the procurement, warehousing and distribution of spare parts to customers world-wide. They have, however, some issues regarding the coordination and the perception of lean. One problem, identified by VP, is divergent perceptions upon lean thinking. The three departments have identified and interpret lean principles differently which is expressed in lack of understanding and communication between the departments. The reasons discussed in VP include different aims and perspectives, prioritization of activities and goals or trade-offs within the supply chain and the supply chain actors.

The business from the MM perspective is to achieve the predetermined service level and optimize the inventory levels. These are the main goals in the MM department and all the activities performed are measured according to metrics evaluating the level of goal achievement. This department, which is responsible for sourcing parts from suppliers, base all its decisions on historical data collected from dealers demand and not in that respect, point of sale. This later issue causes the MM not to be able to always achieve its goal of service level and to create fluctuations in order quantities sent to the warehouses.

On the other hand, WM department which is downstream from MM is affected by decisions taken in MM. This is a result of MM's inability to see the real demand pattern. Hence, while WM experience the piled-up inventories in a period of time, it can also face stock-outs in

some occasions. Furthermore, the suppliers' failure to meet the demand from VP will add up to the warehouse problems and keep it from the best utilization of the time, space and manpower.

The ODM department, at one end of VP internal chain, is also affected by the problems of upstream departments in different ways. One main problem in this area relates to the unavailability of parts at the warehouse when needed. This occurs due to the decisions made in MM and inefficiency in WM's operation as well as the unpredictable nature of the demands. This makes it hard for the ODM department to organize its activities based on the lean principles and its perspective over the continuous flow.

Evidently, using lean thinking in VP's aftermarket supply chain requires the organization's focus on the communication and coordination between all the actors. This implies challenges due to the extreme focus of each department on its own activities but also opportunities as a result of the motivation of VP managers to initiate changes and improvements in the company.

1.3 Purpose

As an aftermarket solutions provider, VP strives to develop its operations and processes. The introduction of VPS and isolated lean initiatives within warehouse operations has highlighted the challenge of analyzing the whole spare part distribution within the different functions of VP. Hence, according to the background and problem discussion the following purpose has been stated:

The purpose of this master's thesis is to investigate and provide an analysis of the challenges and opportunities of applying lean principles in Volvo Parts spare parts distribution.

From the purpose the aim is divided into research questions to further emphasize the areas which are studied and the motivation of them.

1.4 Research Questions

In order to create a more practical way to approach the purpose three research questions are presented which the report should answer.

- What are the market characteristics in aftermarket in terms of logistical flow, customer demand, and distribution?

  The aim is to identify and establish a framework for understanding the organization as an actor in an aftermarket environment. An assessment of the flow of spare part within the organization distribution network and the needs and expectations of customers affect the organization in terms of demand.

- What are the specific resources, activities and capabilities Volvo Parts have which could be exploited or developed by using lean principles?

This presents a description of the organization's operations and processes were lean principles could facilitate a new way of thinking and support the objective towards internal efficiency. The organization's goal to provide aftermarket solutions to the customers also proposes capabilities and activities were lean principles through tools, techniques and methods support an improvement.

- Are there any opportunities that could be exploited in the Volvo Parts logistical flow by using lean principles and how should Volvo Parts utilize such opportunities?

The knowledge of both the market characteristics and context of the aftermarket in combination with the capabilities and activities within Volvo Parts organization will lead to interesting opportunities. The answer to this question, hence, defines were the lean principles could provide best benefits and also how that affect the capabilities of the company to provide competitive solutions.

1.5 Delimitations

The research focus in this master's thesis is VP organization and functions. Therefore, the report excludes the suppliers and customers in the study. The interaction and influence from the suppliers and customers are described out of the perspective of VP. The customers in the report are seen as the dealers and dealerships.

In terms of scope the research focus is the European market. The distribution network is international and includes several nodes with specific areas but it is not handled in this report. One reason is the different characteristics for distribution and other systems used for setting up the operations.

Due to the focus of the report the transportation is studied briefly and there is no deeper research in transport solutions both in the incoming flow into the distribution network and neither in the outbound flow to the customers.

1.6 Volvo Group

Volvo Parts Corporation (in this report referred to as VP) is a firm that offers services and tools to Volvo Group aftermarket. The firm serves seven business segments; Volvo Trucks, Renault Trucks, UD Trucks, Mack Trucks, Volvo Construction Equipment, Volvo Penta, and Volvo Aero. VP is a business unit of Volvo Group with a vast distribution network including 15 000 distribution point worldwide and 32 million order lines. The company has its headquarters in Arendal, Göteborg and have 4 200 employees worldwide. The organizational structure is divided into three divisions; VP Europe, VP Asia & International and VP North America.

The company states its mission as the following; “the mission is to maximise the customer satisfaction and profitability by providing leading-edge aftermarket services to the Volvo Group and other selected customers”.

1.7 Report Disposition

As presented in Figure 1 p.6, the disposition of this thesis is described below:

- The introductory chapter (chapter 1) presents the background, problem discussion, purpose and the scope of the project.
- The methodology, in chapter 2, describes the method used for conducting the whole project.
- Chapter 3, the frame of the reference, is divided into two parts. While the first part outlines the key terms of the thesis title, lean philosophy and aftermarket, the second part goes deeper in the aftermarket structure and provides information on lean warehousing and lean distribution.
- The case description, illustrates the company’s structure and activities from a logistical perspective. This forms the fourth chapter of the report. Due to the current structure of the company, this chapter is divided based upon the different departments, MM, WM and ODM.
- The analysis chapter analyzes the defined problem based on the information in the previous two chapters (chapter 5).
- The discussion chapter highlights the interesting issues from a broader perspective (chapter 6).
- The last chapter is dedicated to the conclusions and recommendations to VP (chapter 7).

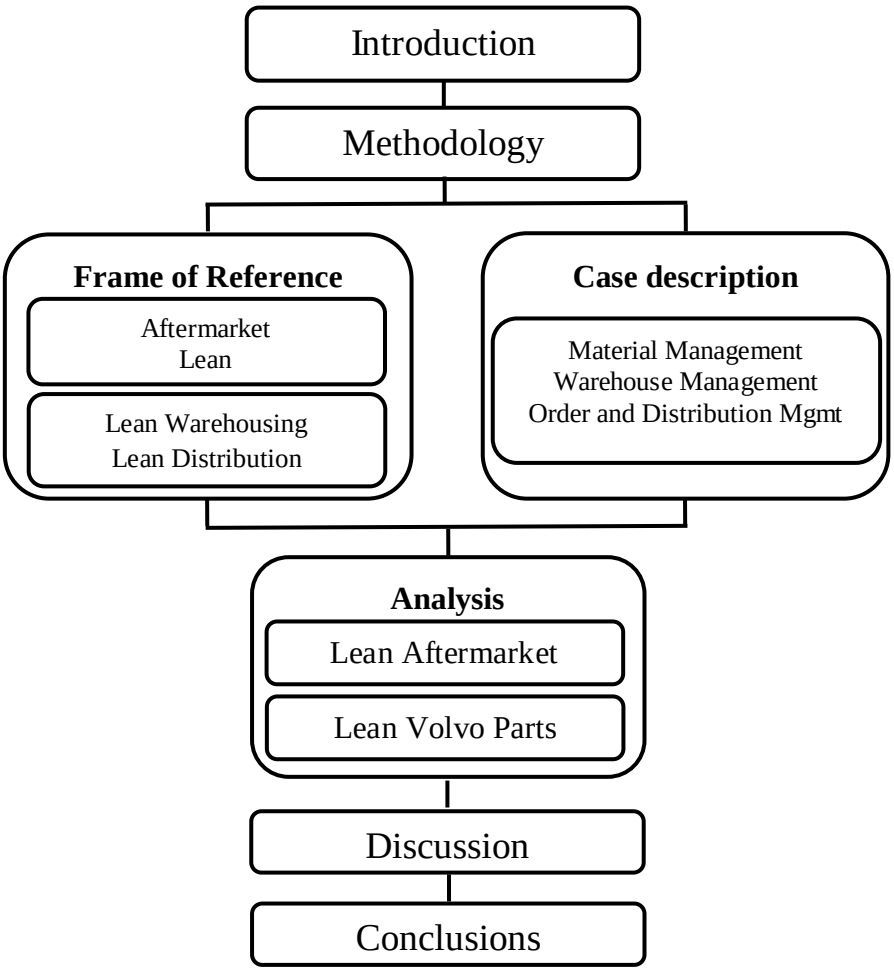

Figure 1 - Report disposition

2. Methodology

In this chapter the research approach and methods of this master thesis are described. It begins with the introduction of the research strategy and the design. Further the methods for data collection are described followed by a discussion about the research quality of the approach.

2.1 Research strategy

In order to meet the goals and expectations of this thesis, the scope and prerequisites for execution have been identified. The starting point is to adopt the three steps described by Kovács and Spens (2005); theoretical knowledge, data collection, and theoretical conclusions. However, a common research approach is to apply an iterative strategy between theory and empirical study (Dubois and Gadde 2002). This idea which has also been refined and adapted to case studies by Dubios and Gadde (2002) introduces systematic combining. The emphasis in systematic combining is on concurrent processes of both the theoretical framework and empirical field. The broad scope of this master's thesis with several actors and vast network will also benefit from this iterative approach. The reason is the need for analytical framework which adapt to changes in theory and empirical information during the whole master's thesis. Hence, the master's thesis employs a tight and evolving framework from lean principle theories and takes it as a point of departure. The theoretical framework is chosen based on the five lean principles and from the case description development it evolves to the essential parts for VP organization.

2.2 Qualitative study

In this master's thesis the research strategy has been applied using a qualitative data collection. As Bryman and Bell (2007) and Trochim (2000) indicate, a qualitative research strategy provides an over-grasping understanding of the phenomenon and therefore facilitates understanding and filling of the gaps within the field of interest. The interpretation and mental models from the interviewees in the case description combines this qualitative study with the VP case study. This exemplifies the current situation and how lean principles could affect the operations in VP.

A case study design provides a framework for the data collection and analysis (Bryman and Bell 2007). Given the fact that this master's thesis is focusing on the investigation and analysis of the VP internal supply chain, the framework is adapted based on the organizations structure and needs. Moreover, the level of analysis in this master's thesis is on an organizational level as the study is covering several departments in the aftermarket solution within VP.

2.3 Data Collection

Data are the facts about the object of study (people, objects or phenomena) and the settings in which they occur. Data collection, thus, is the act of gathering these data systematically (Chaleunvong 2009). To be able to capture the complexity and contradictions in data, one should use different research methods (Bryman and Bell 2007). The data collection phase in this report, hence, includes two main sections, i.e., collecting empirical data through interviews and observations. The following section covers the detailed description of each method and the overall quality of the research will be addressed in a later section in this chapter.

2.3.1 Empirical data

A considerable part of this report is based on the analysis of the empirical data which has been directly collected by the authors. This data has been collected mainly through the interviews and direct observations.

Interviews

The main method of interviews used in this report is the one Bryman and Bell (2007) refers to as "qualitative interview". The qualitative interviews, which are appropriate for qualitative research, consist of both semi-structured and unstructured interviews when the interviewers have a list of general questions or topics as the "interview guide" and therefore, are flexible in varying the sequence of the questions based on the discussion's direction (Bryman and Bell 2007).

The reason to perform these interviews has been to map the structure of the activities and processes within VP. It is believed that the most efficient method to understand the working process of the company in the short time span of this thesis is to discuss it with the experts in the organization. Hence, using this method has helped both the authors and their interviewees to have a discussion around the relevant questions. Furthermore, it has enabled the interviewers to have the possibility of asking further questions in order to achieve clarification. In addition to the interview itself, the authors have also employed what is referred to as snowball sampling method (Bryman and Bell 2007). Snowball method in this case was a technique through which the authors have used the interviewees' social network to establish contact with other relevant employees in the company. This method has been selected due to the structure of the company. Since the structure of VP is on a functional-oriented basis (see section 3.2.2 (flow) for more information) the employees in each department do not have sufficient knowledge about the activities done in other departments. In this respect, snowball method helped the authors to get the answers of their questions from a relevant expert. Nevertheless, it has been considered that snowball method can increase the possibility of interviewing the employees with the same view upon the situation.

During the interviews, which were generally conducted face-to-face and in one case through the phone conference, a total number of 16 employees within the company have been interviewed. These employees were selected from different fields of MM, WM and ODM. A full list of these employees' names and their responsibilities within the company in addition to the interview guide used for the interviews can be found in the Appendix.

An interview investigation consists of seven different stages, i.e. thematizing, designing, interviewing, transcribing, analyzing, verifying and reporting (Kvale 2009). Therefore, the process of the interviews in this thesis with respect to data collection includes the first four stages. Thematizing or formulating the purpose of the investigation has been done by the discussions the authors had before each interview. This phase has been followed by preparation and designing phase in order to list the relevant questions or topics. This has been done by brain-storming sessions with the aim of collecting and prioritizing all the relevant questions. Since the main purpose of the interviews has been to acquire relevant knowledge of the company, in the execution phase, the interviewers have interacted as much as possible with the interviewee and tried to clarify all the aspects of the discussed topics by asking further questions. Directly after the interviews, the transcription phase has been started to transcribe the notes. The most important issue in this phase has been to make sure not to mix their interpretations with the statements by the interviewee. To do so, the interpretations and analyses have been written under a separate section within the same document.

Observations

Observation is a technique for systematically selecting, observing and recording an especial phenomenon. Observations are carried out in order to record the details of the participants' behavior for analysis purposes (Bryman and Bell 2007). Furthermore, observations can be performed as participants where the researcher also takes part in some of the tasks done by staff (Marshall and Rossman 2006). Participant observation has been used in this thesis in order to follow the activities done in the warehouse from the beginning to the end.

2.4 Literature Study

In addition to empirical data collection in terms of interviews and observations, literature study has been also done in this thesis to reinforce the future results with the theory and researches already done in this area. The major sources of this study were articles, books, reports and electronic sources. The main purpose of this study was to build the theoretical framework of the study which is then used as a basis for the analysis and as guidance for deciding what empirical data is needed and later cross-checking. The following section will give an extensive overview of the approach towards the literature study.

The literature study in this research, as mentioned earlier, has been done by the means of searching through different sources. This investigation has been performed by searching for the relevant keywords in scientific databases (Emerald and Science Direct) and selecting the corresponding ones. These key words used were: aftermarket, lean principles, lean thinking,

lean logistics, lean warehousing and lean distribution. Another helpful approach in this context was searching in the bibliography of the interesting articles and books to find other related literature. Scanning and skimming the literature has provided the opportunity for attaining the sufficient knowledge as well as understanding the industry and its unique characteristics. This has also helped to narrow down the searches to the most relevant areas during the later stages of the literature study.

Among the different literature, best practices and case studies are perceived to be one of the best sources of information for inspiration purposes. Case studies also assist to increase the knowledge of the challenges and mistakes done previously. However, it is of high importance to keep in mind that lean concept is adapted to the context. It is believed that the lean system should be a customized unique system for each company which is dependant to several factors including the company's culture. Thus, while the authors have put sufficient effort on gathering information about the best practices, they were highly aware to use that as a source for inspiration and learning about the points of success and failure in different industries.

A useful approach in the literature study followed by the authors was the summary notes taken during the process. This has contributed to a better information classification as well as writing the report later. In addition, since the research done in the lean field is numerous, a careful attention has been paid to ensure that the gathered information is among the updated and recent research.

2.5 Reliability and Validity

Evaluation of business and management research is critical to ensure high research quality. In order to be able to vouch for the quality of the master thesis two criterions are used; reliability and validity (Bryman and Bell 2007).

2.5.1 Reliability

Reliability is important in a qualitative study to ensure whether the results are repeatable (Bryman and Bell 2007). Reliability is similar to the criteria of replicateability and since the report uses qualitative methods, it therefore, needs to verify external reliability which indicates to what extent the study could be replicated. Generally, replication is used to see if the same results could be achieved under similar circumstances in the setup and environment. As the study is extensive based upon interviews and observations, therefore is it essential to ensure the reliability in the research methods.. Interviews have their point of departure from a framework which should create consistency in the study (Bryman and Bell 2007).The chosen semi-structured interviews conducted at VP could affect the replicability but the degree of flexibility in the interviews was valued higher. To address these issues the interviews were prepared in advance and transcribed in direct afterwards. These transcripts were controlled and verified between the interviewers to minimize discrepancies in the interpretation.

Internal reliability concern the question of if a problem or phenomenon is perceived similar agreed upon between the observators and interviewers. Bryman & Bell (2007) define this as inter-observer consistency. Cross-checking transcripts from interviews and observations are important to increase the internal reliability in the study. This knowledge has been used between the interviews of warehouse managers and the observations executed at the warehouses.

2.5.2 Validity

Validity is a measure of the integrity of the findings which are generated from a research study. That means to what extent the observations and theoretical concepts correspond to the reality (Bryman and Bell 2007). The focus on the literature study and interviews supports the strength of the internal validity of the report. This has been done by screening literature and using credible sources (scientific journals, internal reports and documents) as well as internal documents and reports from VP.

The interviews are the second part in the internal validity and as described in the reliability a framework have been used. In the initial phase of the master thesis, all the departments have been notified about the research study and its purpose. Prior to the interviews all the interviewees have been informed of the purpose and the field of discussion to establish a shared perception. To further increase the validity of the interviews, the summary of the discussed topics was provided to the interviewees to give them the opportunity to change or elaborate upon specific areas. In the study and interviews a snowball and judgment sampling method were used. The snowball method has a bias to increase the risk of causal relationships. To engage this and therefore increase the internal validity a triangulation has been made by interviewing the employees in the same department. In the judgment sampling method the sponsor of the master thesis used its social network in combination with the areas of interest.

External validity concerns the extent to which the findings could be generalized in other contexts and settings (Bryman and Bell 2007). Qualitative research strategies with case study design do have strong internal validity but lacks external validity due to its nature. In order to improve the external validity Bryman & Bell (2007) emphasize on an extensive description of procedures and the culture in order to be able to transfer the findings onto other contexts. In this report there is a possibility to use the findings within VP worldwide and the parts of the report in other aftermarket context.

3. Frame of Reference

The following chapter includes the outcome of the literature study performed to serve as the framework for the analysis and discussion. This section, hence, will be further employed in the analysis. However, some sections are included with the intention of educating the reader about the area of the study and its characteristics. The structure of the chapter is to first start with the aftermarket characteristics and its distinction from other business markets. Then the chapter looks upon the lean philosophy and principles and describes the important issues to be considered in each principle. Lastly, the section is continued by studying the lean perception on the two main aftermarket areas, i.e. lean warehousing and lean distribution.

3.1 Aftermarket

Selling the products to the customers is not the end of companies' responsibilities. Companies are also in charge of customers' support after the sales takes place. Hence, a new business chain starts right after where the manufacturing supply chain put an end to its activities and that is the so-called aftermarket supply chain. Aftermarket business is a stream for companies to both meet the customers' after-sales needs and to earn considerable profit. According to several studies, although the after-sales services and parts might not contribute more than 10-15% to revenues, it creates a large part of the profit margins up to 50% (Bartwal, et al. 2010, Cohen, Agrawal and Agrawal 2006, Herbig and Palumbo 1993). It also enables companies to build up loyalty and tight bonds with their customers and create repeated sales on the products they have already sold. As Phelan et al. (2000) point out in unstable markets this is as important as finding new customers.

Aftermarket business creates several strategic benefits for companies. Cohen et al. (2006) makes clear some of these benefits as a source for low-risk and long-term revenue, incurring less cost than finding new customers and understanding the customers' technologies, processes and plans. In addition, in today's business world where the competition on the technological advantages is highly intense, aftermarket service is a key differentiator for customers (Herbig and Palumbo 1993). However, most of the companies have not been aware of such huge opportunity until very recently. Many studies have indicated the trend in which companies used to see the aftermarket business as the unnecessary costs and hence have been reluctant to invest or spend resources on it (For example see: Cohen et al. (2006); Phelan et al. (2000); Herbig & Palumbo (1993)). The recent dramatic change in customers' expectations towards demanding support, services and solutions throughout the whole product life time has underscored the importance of the aftermarket for companies.

Nowadays, companies offer many different types of services in the aftermarket. Among them product warranties, service facilities, help desks, spare parts, on-site support and product training are only a few to name (Phelan, Griffiths and Steven 2000). Nevertheless, competing in the aftermarket supply chain is a tough task. This is mainly a result of the characteristics the

aftermarket supply chain inherits and its differences with the normal supply chain. Firstly, the aftermarket should cover all the company's products. Since each product has many different parts and suppliers, the aftermarket supply chain should cope with more stock keeping units (SKU) than the manufacturing supply chain. The underlying reasons are the products short life cycle and also the commitment of providing spare parts during the life span of the product. Hence, the difference between the manufacturing SKUs and the ones in the aftermarket could be as large as 20 times more in aftermarket (Cohen, Agrawal and Agrawal 2006). Secondly the demand pattern in aftermarket does not follow a stable predetermined pattern and can be more characterized as erratic. Moreover, the demands for different parts might be highly different when it comes to volumes. Some parts have very low to zero demand. However, those parts might be expensive and critical and hence, difficult to control (Martin, et al. 2010). Thirdly, delivering the aftermarket services is more complex than delivering the products in manufacturing supply chain. In aftermarket, companies need to deploy parts as well as the people, equipments and infrastructure in more locations than they do in the manufacturing to be able to meet the needs of the customers.

The complexity of aftermarket is not limited to the above characteristics. Reverse logistics as an essential part of the aftermarket supply chain makes the situation even more problematic and harder to manage. The flow in the aftermarket is often consisted of two parts; forward flow and reverse flow. While the forward flow deals with the parts distribution strategies, the reverse flow is more concerned with return process (repair or disposal of failed components), warranty management, information and monetary flow (Bartwal, et al. 2010). Reverse flow covers a considerable part of the flows in aftermarket. A study by Daugherty et al. (2003) shows that in the automotive industry, the return flow ranges from 15% to 20% of the sales. They further categorize the reverse flow into two classifications, namely, the expected and unexpected reverse flow. The expected flow includes the flow of parts which are returned to the company for remanufacturing. On the other hand, the unexpected flow occurs when there are wrong and damaged shipments.

The complex characteristics of the aftermarket supply chain imply the important role of two fundamental factors: forecasting and information sharing. As Cohen et al., (2006) highlight, when talking about the forecasting in aftermarket, most of the companies employ the same approaches they use in their manufacturing supply chain, i.e., enterprise resource planning (ERP) thinking and software solutions to overcome the aftermarket difficulties. However, as a result of the sporadic nature of demand in the aftermarket such approaches will lead to mismatches between the demand and supply and accordingly poor service levels. The role of forecasting in aftermarket, as Cohen et al. (2006) indicate, is only to determine the probability of distributions and attempt to minimize the risks. Other authors have the similar views on the forecasting in aftermarket. Baudin (2004) for instance, points out that companies should not see forecasting as executing simple algorithms based on the past data. Instead, he believes this should be used in combination with the main inputs from the sales force, customers, and leading economic indicators. Subramoniam et al. (2009) also points out that companies usually spend a significant amount of money on the demand planning tools, while one

innovative solution in the environments such as aftermarket with wide variety of parts is to adapt the postponement strategies.

Information sharing which is a crucial factor in normal supply chains is of higher importance in the aftermarket supply chain due to its especial characteristics. Many companies in normal supply chains share their information regarding the demands, production schedules and inventory level directly with their major suppliers. This creates the transparency and avoids the problems such as the bullwhip effect. The bullwhip effect which is a result of distorted information in the supply chain refers to the situation when the demand variability increases in the supply chain as one goes upstream in the supply chain (Lee, Padmanabhan and Whang 1997). While using the information sharing technologies will make the customer service process easier to manage, Phelan et al. (2000) argues that this issue has been neglected by the actors in the aftermarket supply chains. Hence, better communication and collaboration as well as sharing the risks between parties are key factors for companies to undertake.

3.2 Lean Philosophy

In the last decades of the previous millennium lean philosophy has been recognised and received a worldwide reputation both by researchers and practitioners (Åhlström och Karlsson 1996). The lean philosophy stems from the automotive manufacturer Toyota and has been known in the western world as lean production. The development and interest started in the manufacturing part of the supply chain have evolved and span from cradle to grave with lean supply and lean distribution. In this section lean philosophy and principles are introduced and aiming at the aftermarket.

3.2.1 Lean history and definition

Lean philosophy has its beginning in the post second world war, Japan, to provide automotive solutions with scarce resources. The most influential actor in this aspect is Toyota and the Toyota Production System (TPS). The TPS derive from practices and principles applied by Henry Ford in the beginning of the 20th century and were influenced from the mass production (Hines, Holweg och Rich 2004). This idea was developed to organize an efficient manufacturing operation with high volumes and low variety in mature, stable markets.

Defining the essential bricks in the giant puzzle of lean is difficult but there are several researchers which has investigated the core and fundamental pillars in lean philosophy. The two fundamental pillars determining TPS are just-in-time (JIT) and autonomation. JIT is defined as executing activities at the right time, at the right place and in the right quantity (Ohno 1988). Autonomation refers to the productivity of employees in the organization and differs from the common view upon productivity as optimizing the system. Another perspective by Shingo (1989) is to identify waste and increase the productivity through continuous improvement and elimination of waste.

Lean manufacturing is based on creating value for the customers with as few resources as possible (Poppendieck 2002). During the recent decades, lean philosophy has been able to help companies in different industries to work more standardized and efficient and to achieve the better results through smaller investments. Although it started in a manufacturing industry and is still more common among production companies, lean has also opened its way through logistics, military, construction and service industry (Poppendieck 2002). As suggested by Kilpatrick (2003), the benefits achieved from employing lean in the organizations include different areas such as administrative, operational and strategic. However, most of the organizations implement lean only for the reason of its operational improvements. These areas will be described and elaborated further within each lean principle.

Although lean implementation in the organization has been proved to bring along considerable improvement, the transformation process creates lots of challenges for the companies. There are many reasons why companies might fail to implement lean successfully. Some of the reasons include: failure to translate the improvement metrics to the financial statements, choosing the wrong sequence of improvements (such as lowering the inventory levels prior to improving the flow), starting from difficult projects with low impact, spending too much time on training rather than doing and failure in expanding the improvements to the whole supply chain (Kilpatrick 2003).

As Kilpatrick (2003) defines, lean is:

"*A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection*".

According to this definition and as Womack and Jones (2003) also point out, the building blocks of lean methodology consists of five principles: value, value stream, flow, pull and perfection. These principles can be set and improved successfully if only the culture of trust and empowerment exists in the organization (Jones, et al. 1999).

3.2.2 Lean Principles

The five different principles of the lean thinking, as shown in the following figure (Figure 2), are presented in the next coming sections in order to shed some lights on the ways the organizations should practice these principles.

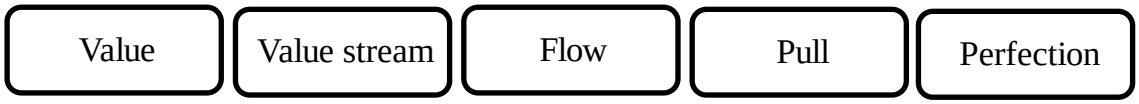

Figure 2 - Lean principles

Value

The very first step towards lean is to identify value. This will further help companies to be able to map their processes and try to eliminate all other activities which only consume resources. Value in lean principles, refers to all the activities which are worthy in the eyes of the customers. Hence, the first step is examining the processes from a customers' point of view. These customers should both include the internal customers, i.e., those who are at the next process, and the external final customers (Liker 2004).

A proper approach in defining the value is to propose questions such as: what the customer wants and what they are willing to pay for. Following such an approach will assist to distinguish between the value and what is described as waste (in Japanese muda) in the lean literature. The key element in this respect is for the companies to jointly analyse the values with their major customers and challenge their old definitions.

However, while identifying value, one should be aware of the common traps companies usually fall into. Value is not simply equal to lowering the costs and increasing the product variety through customization or instant delivery. It is not necessarily about using the present production or distribution configuration either (Womack and Jones 2003). Companies should be ready for dramatic changes which set the activities in a way to serve the customers' actual needs. Knowing this fact, companies should also learn to identify value they need to look at the whole product chain and not different firms in isolation (Womack and Jones 2003). As long as each firm is thinking about their own operational efficiency, the lean principles will not be applicable. Womack and Jones (2003) makes clear that the appropriate definition of product will change (and so does the definition of value) as soon as you begin to look at the whole through the eyes of the customer.

After defining the actual value in the process, an important task for the companies would be to rethink their defined value continuously and make sure if they have identified it to the most accurate level possible (Womack and Jones 2003). There is also one final step in defining value and that is setting the target costs. Setting the target cost will help companies to remove all the waste from the process (ibid). Lean companies normally set a target cost for their products considering the situation as the one without any possible waste and since this cost is always a lot less than their traditional competitors, they will have plenty of options for further developments in the company. By defining the ultimate state, organizations could imagine a future state and set a direction rather than a goal.

Value Stream

Hines and Rich (1997) identify three different types of activities. These are:

- Non-value-adding
- Necessary but non-value-adding
- Value-adding

The ultimate target of the lean methodology is to separate the value-adding activities from non-value-adding ones and remove all the waste from the process. However, Hines and Rich (1997) make clear that considering the current operational procedure of the companies, the second category is inevitable at the moment. Hence, the second lean principle starts by focusing on the first and the third category of the activities to identify the low hanging fruit.

In order to be able to create the perfect value stream in which all the activities add value to the product or service, it is needed to challenge, improve or eliminate (if necessary) the current activities done for providing a product or service. Companies should therefore be able to identify, analyse and link those activities together (Womack and Jones 2003). Mapping the value stream will help companies to identify the waste within the processes and sort the activities according to the three categories mentioned above. There are 8 identified types of waste in the company's operations, namely, over-production, waiting, unnecessary transport, over-processing, excess inventory, unnecessary movement, defects, and unused employee creativity (Liker 2004).

Hines and Rich (1997) introduce seven different tools for value stream mapping each of which has different level of correlation with the different types of waste. Hence, after identifying the main sources of waste in the operations, companies are able to choose among the most relevant tools. The tools used in value stream mapping are: process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis and physical structure (a) volume (b) value (Hines and Rich 1997). Table 1 illustrates these seven tools and their ability to visualize different types of waste.

After identifying the waste in the value stream mapping companies need to search for the root causes of the waste and try to correct the process as much as possible (Womack and Jones 2003). Attacking the root cause is essential to remove the waste permanently and therefore go from fire-fighting mode aiming at the effect and becoming more proactive and hence go to the source of the problem.

Table 1 - Seven tools of value stream mapping, adapted from Hines and Rich (1997)

Wastes	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification Mapping	Decision Point Analysis	Physical Structure (a)Volume (b)Value
Over-production	L	M		L	M	M	
Waiting	H	H	L		M	M	
Unnecessary Transport	H						L
Over-processing	H		M	L		L	
Unnecessary Inventory	M	H	M		H	M	L
Unnecessary Motion	H	L					
Defects	L	L	M	L	H	M	H
			H: High correlation	**M: Medium correlation**	**L: Low correlation**		

Flow

The next step after defining value and identifying the value stream is to make a smooth flow for the value stream. This simply means to remove all different kinds of stoppage, scrap and backflows from the process. The ideal flow according to lean thinking is the one in which the product flows continuously through the whole value stream from the raw material to the final customer (Rother and Harris 2001).

Womack and Jones (2003) distinguish three steps to create the flow in the supply chain. These steps which should be taken together are:

- Focus on the whole product from the beginning to the completion.
- Ignore the traditional boundaries of jobs, careers, functions and firms.
- Rethink specific work practices and tools to eliminate backflows, scrap, and stoppages of all sorts.

In this approach, while the first step implies to have a holistic view over the whole supply chain, the second step brings the difference between the traditional and lean organizations into the picture. Jones et al. (1999) describe some of the characteristics of the traditional organizations as working in functional departments where each department is specialized only

in a specific area, having big batches in the system, producing goods based on the forecasts, pilling up inventories and being cost-centric. In the contrary, the lean organizations are those with the process-oriented activities which have replaced the batch processing with one-piece-flow (and consequently minimum level of inventory) and set the focus on the customers' actual value.

The continuous flow can be established in all different parts of the company. This includes the design process, order-taking process, production, and distribution (Womack and Jones 2003). However, Rother and Harris (2001) suggest that creating a continuous flow is not an easy task and companies need to place a focus first. They further recommend the companies to identify the pace-maker (where the product takes its final form for the final customer) and start making the flow from there. Concepts and tools such as transparency and visual control, standardization, 5S and status indicators are also believed to help in creating the flow (Womack and Jones 2003). Standardization could be using 5S to develop activities of sort and straighten the working environment and hence help the goal to find waste and deviations easier.

Although creating the flow is one of the highly important principles of lean thinking, it will not work alone and there is still the need to tie all the parts of the value stream together. Pull, the next principle in lean thinking, is the missing chain in this respect.

Pull

Pull as the fourth principle of lean philosophy is defined by Womack and Jones (2003) as the situation when the upstream only produces goods or services if there is a demand from the downstream customers. This definition can be interpreted as the make-to-order philosophy. However, Hopp and Spearman (2004) propose a more precise definition for pull which differentiate pull from the make-to-order processes in some ways. They argue that pull production system is the one which "explicitly limits the amount of work in process (WIP) that can be in the system". They base this definition on the fact that waiting for customers to order, before starting to produce can be complicated. Additionally, they distinguish between what is called the pull strategy and tactics. It is believed that the cornerstones of the pull strategy are the standard work methods and level scheduling while the tactical pull is about setting the pace of the production equal to the takt-time (the rate of customers' demand) and adjust it continuously (Hopp and Spearman 2004). Level scheduling is enforced by standardize activities which makes it easier to allocate personnel.

Using pull systems will provide companies with the ability to reduce the WIPs and inventories in the supply chain and have a smoother production flow. It will also enable improved quality and reduced costs since the defects are more visible and hence, critical when the amount of WIP reduces (Hopp and Spearman 2004).

Perfection

Perfection or complete elimination of waste is the final principle in lean thinking. Perfection consists of two complementary approaches, namely, Kaikaku (radical change) and Kaizen (continuous improvement). Radical changes or Kaikaku refers to all the fundamental changes a company need to implement in order to move towards the lean enterprise (Womack and Jones 2003). Kaizen or continuous improvement includes all the incremental improvements needed afterwards. Hence, Womack and Jones (2003) present two final lean techniques for pursuing perfection: applying the first four lean principles and then decide on the most important waste in the system to remove. This later technique can be approached through the policy deployment by the top managers. The key steps in policy deployment for top management is to agree on a few simple goals, select a number of projects in order to achieve the goals, assign people and resources to the project and to set up measurable numerical targets to be achieved in the projects in a specific time framework.

3.2.3 Lean Warehousing

The following section presents the lean perception of warehousing from a literature point of view. This section starts with a brief introduction on warehousing and its embedded characteristics and activities followed by the necessity of warehouses' existence from the lean perspective. The lean warehouse and common wastes in the warehouse is discussed later in the final parts of this section.

Warehouse Management

Warehousing is considered as different material handling activities which are performed in a factory's warehouse. These activities include all types of inbound and outbound processes such as receiving, binning, picking and shipping. Warehouses serve a number of purposes which affect their characteristics. In that respect there are normally three different types of warehouses, i.e. production warehouse, contract warehouse, and distribution warehouse. A production warehouse is involved in storage and management of the inventories needed for production such as raw material, WIPs and finished goods. A contract warehouse is a warehouse managed by a third party, serving and providing warehouse operations to the company. A distribution warehouse takes care of the activities related to the sourcing of the products from different suppliers and distributing them to the customers. This may also include assemblies if needed (van den Berg and Zijm 1999). According to this definition, the aftermarket warehouses are considered as the third type, namely, the distribution warehouse.

As mentioned earlier, due to the complex characteristics of the aftermarket business, warehouse management in the aftermarket experiences additional challenges than the other types of warehouses. Kalchschmidt et al. (2003) point out the major challenges in the spare parts warehouses as high numbers of SKUs, low inventory turns and considerable holding costs. Therefore, managing the activities and resources in the aftermarket warehouses is critical and should be one of the high priorities for companies dealing with aftermarket

business. Warehouse design and its management are developed from the decisions based upon the investment needs and importance for operations. These decisions could be taken in different levels in the hierarchal organization and therefore classified as strategic, tactical and operational affecting the goals and incentives for the daily activities (Rouwenhorst, et al. 2000).

The strategic decisions in warehouse management deal with the long-term decisions with high investment requirements. Examples of this type of decisions are the selection of the technical systems and the design of the process flow in the warehouse. On a lower level, there exist the tactical decisions which concern the medium-term decisions. This type of decisions which are restricted by the strategic decisions covers issues such as the layout design, selection of equipments and the dimension of the storage system and need medium level of investment. The lowest level decisions made in WM are the operational decisions with low amount of investment. This type of decisions which should be made within the frames of the strategic and tactical decisions includes the decisions related to control and assignment of people and equipments (Rouwenhorst, et al. 2000). Since the scope of this project only covers the tactical and partly operational levels, the remaining parts of this section is only devoted to those levels.

Generally, warehouse management consists of taking three different aspects into consideration; processes, resources and organization (Rouwenhorst, et al. 2000). Processes include activities where parts are handled. The four main categories of activities in the warehouse are receiving, storage, order-picking, and shipping (van den Berg and Zijm 1999). Resources refer to the equipments and personnel needed to perform the processes. This ranges from the storage units and systems to material handling equipments, computer systems, and personnel. Finally, organization comprises all planning and control procedures and policies to run the system (Rouwenhorst, et al. 2000).

Apart from the wide range of manual, automated and automatic practices and methods companies use to manage their warehouses, the ultimate goal of the warehouse management is to create a balance between the costs and customer satisfaction. Hence, this trade-off should cover many different factors such as inventory control decisions, product allocations, design challenges, service levels and response time (van den Berg and Zijm 1999). Since the main source of costs in the warehouse is order-picking process which accounts for 50-75% of the costs, companies usually try to come up with the solutions to optimize the order-picking (van den Berg and Zijm 1999, Rouwenhorst, et al. 2000, Petersen and Aase 2004). Lean is a common approach companies employ to optimize their working process in the warehouse. However, it is interesting to see what the lean point of view is on warehousing and its activities.

Lean Perspective in Warehouse

One of the major sources of the waste in the supply chain is recognized by lean thinking to be the inventory. However, there is sometimes a misinterpretation by practitioners to think that any type of inventory is waste and hence should be eliminated. Thus it is of high importance to clarify what lean counts as waste. From the lean perspective inventory by itself is not waste but accumulating excess inventory is considered to be waste. Although the ultimate goal of lean philosophy is to create one-piece-flow where there is no inventory in between the processes, the existing challenges in reality makes this goal hard to achieve. So, lean approach is not against keeping inventories but emphasizes on keeping the exact amount of inventory needed to satisfy customers.

There are some reasons why companies need to stock inventories. Among them the mismatches between the incoming and outgoing volume and fluctuations in demand or supply are the most important ones. As Baudin (2004) explains when the amount of incoming goods is not equal to the demanded amount the need to store the products arises. He further points out that working only with perfect suppliers who are always able to deliver the exact amount on the right time and with perfect quality is unreachable which in turn makes the existence of the warehouses necessary (Baudin 2004). In addition, uncertain and variable demand pattern also rationalizes the need of warehouses in order to be able to handle the demand's peaks (Baudin 2004).

However, the biggest mistake the companies normally make is to use the inventories to hide their problems. The problems such as inability to respond to the demands due to the bottlenecks and problems in the supply chain can be hidden (and of course not to be solved) by keeping high levels of inventory and safety stock for all the parts. Lean perspective on such inventories explicitly states that the root causes of the problems should be discovered and solved and the levels of inventories should be reduced, respectively.

Eliminating waste

Lean principles have been first introduced in the production. However, later it was adapted to different areas such as distribution, military, service and so on. The same exists with the eight types of waste. The waste sources which were introduced in the earlier sections can be translated in the warehouse. Waste in the warehouse is all the activities which absorb resources but does not create any value. Shipping and receiving errors are examples of waste in the warehouse (Ackerman 2007). The eight waste sources in the warehousing operations are: faster than necessary pace (over production), waiting, unnecessary movement (unnecessary transportation), over processing, excess inventory, unnecessary motion, errors (defects), and unused employees' creativity (Davies 2007).

The wastes which result in long lead times, increased errors, and huge handling costs, can be prevented by levelling the work, setting expectations with standard work assignments, ensuring the availability of the tools, redesigning processes and using visual controls. By

reducing the waste in the warehouse companies will experience more flexibility in the storage, reduced storage and handling costs, decrease the chance of damages and errors and better availability and response time.

Lean warehouse

In a lean warehouse the final objective is to deliver the right goods in the right quantity and free from any damage or error to the customer at the exact time they want it (Ackerman 2007). To define a lean warehouse two perspectives can be taken into consideration: an aggregated perspective and a more detailed one. Considering the lean warehouse from a high-level holistic view, the implementation of the five lean principles should be visible in all processes. Value in a lean warehouse is defined the same as the customers' value i.e. the availability of right parts in the needed time. Hence, all the warehouse processes should be designed so that they serve the purpose and meet the customers' needs and expectations. Consequently the value stream mapping in a lean warehouse maps all the processes in material and information flow from the shipping area back to the suppliers. The mapping should be started by considering a product group in order to avoid the map being too complicated (Garcia 2003). After mapping the current situation and defining the future state along with the values, an implementation plan consisting of time-sequenced improvement projects should be created in order to help the warehouse to have a path through the transformation.

In order to create the flow in the warehouse, Ackerman (2007) suggests to monitor and reduce the order cycle time. Order cycle time which is defined as the time span between the receipt of an order and delivering it to the customer is achieved by improvements in the flow of material and information. He further argues that the flow can be improved through the reduction of the number of products' movement during the warehousing process. In the same way the information flow will be improved by reducing the probability of the data transmission errors (Ackerman 2007). Moreover, pull in the lean warehouse refers to retrieving the material whenever there is a demand for them from the customers. Lastly, perfection in the warehousing operation, relates to what is called "the perfect order" meaning that to deliver what a customer exactly wants where and when he orders it (Ackerman 2007). Perfect orders need the perfect inventories as a prerequisite since it is not possible without accurate stocks.

To implement the five lean principles practically, having a detailed perspective is inevitable. The main problem in the warehouse management in this respect is the one-size-fits-all policy without considering the volume and frequency. This usually happens in companies as the managers are often familiar with only one method or the warehouse management system has limitations which makes the use of several methods impossible. What makes a lean warehouse stands out is the use of multiple methods for different parts with different needs (Baudin 2004). The parts classification is typically done according to the frequency of use, volume, similarities in handling characteristics, and size (Baudin 2004, Davies 2007).

The first step towards the lean warehouse is to create an organized facility by establishing an organized layout, visibility, work standardization, security, and tracking. This will result in optimized work process as well as clean and comfortable work environment with safety and ergonomic considerations (Davies 2007). As mentioned earlier the parts in the warehouse should be grouped by the classification criteria such as the frequency of use and volume. In such way the most frequent parts will be more accessible with allocation of fixed locations closer to the receiving/shipping area while the infrequent parts can be dynamically allocated to the empty slots (Baudin 2004). However, the sequence of the layout design can also be influenced by the factors such as the size of the warehouse, the quality and delivery performance (Baudin 2004). Another issue in creating an organized layout is to implement the 5S principles to have a place for all the parts and equipments and to keep everything in their places. The benefits gained from this tool are to reduce the product damage, increase the picking efficiency, better utilization and improved safety.

While designing a warehouse layout, an important concern is the percentage of occupancy in the warehouse. According to Baudin (2004), in spite of the common perception that a warehouse should be full to its maximum capacity, studies show that the safety and productivity generally falls considerably when the warehouse occupancy exceeds 85% to 90%. The reasons behind this phenomenon relates to the inability to keep the integrity of parts and the needs for slot-hunting. When more than 85% to 90% of a warehouse is occupied, the workers might need to fragment the pallets and bin them wherever the slots are available. In addition, even if fragmentation of the pallets may not be necessary, there is still a need for slot-hunting which is usually a problem since the available slots in a nearly full warehouse are those in the highest reaches and the longest distance from the starting position of the picking operation.

The second issue in transformation to a lean warehouse is the extensive use of the visibility to avoid the employees' confusion and to reduce the time waste and errors to the maximum extent possible (Davies 2007). There are six ways to improve the warehouse visibility, namely, location labelling, dock identification, zone identification, rack identification, slot separation, and rack orientation (Baudin 2004).The main point in the warehouse visibility is to make the signs visible from all the sides. This means to put the location signs on all sides of the grid of columns, put the dock identification signs on the side of the dock where the sign is visible even when the doors are open, use triangular signs above the zones and to use a standard, self-explanatory method for racks identifications (including signs for aisles, columns within the aisles and the levels within the columns). The sixth improvement approach, rack orientation, simply means to put the racks in a way that the inside of the warehouse is visible from the receiving area (Baudin 2004).

The third concern in warehouse transformation is to create a best practice. There should be always a best practice on how the specific tasks should be done. This helps the warehouse to employ the best practices in all the tasks. Along with the standardization, the employees should always be motivated to think of the ways to improve the best practice, since they are

the best ones who know everything about the tasks. In addition to best practice, the time span needed for completing assignments should also be measured so that the work pace can be monitored and the allocation of personnel can be planned (Davies 2007).

Lastly, security and tracking are important factors to be considered in lean warehousing. Tracking the flow of material is the only way to keep the inventory's accuracy. The material from the warehouse should be only pulled by the customers and the parts should not be moved or touched without a pull sign. In order to move the parts from the warehouse, material handlers should be the only ones who have the eligibility of touching the parts and they should not move the parts without recording the part number and quantity. RFID technology is a big help in automating the recordings in the warehouses. The security in the warehouse should also be kept to a good level without creating more work or waiting for the employees.

3.2.4 Lean Distribution

In this section the focus will be upon the lean principles and the downstream supply chain. The aim of this section hence, is to understand the internal and external customers as well as the consumption patterns and logistical flows. This understanding is a leverage to create sustainable competitiveness and contributing to the revenue growth and profits.

Definition

Defining the lean distribution is associated with problems defining the scope and boundaries. What is supported by both Reichhart & Holweg (2007) and Baudin (2004) is that lean distribution stems from the lean principles presented earlier in the report. The starting point is to strive for using lean from cradle to grave to retrieve competitiveness and utilizing the resources efficiently and achieve customer satisfaction for the solutions provided. The recent development from the manufacturing perspective towards the supplier side and later in the distribution, has created the interest in using lean principles downstream in the supply chain all the way out to the customers. The motif is an untapped potential of improving the distribution and logistical processes. Developing these processes increase flexibility and simplicity which serve as an enabler for value creation and efficient use of resources.

Jones et al. (1997) introduces lean logistics as operations needed to provide and deliver solutions towards the customer. The scope of lean logistics embraces all activities which go both upstream and downstream the value stream. The lean distribution scope defined by Reichhart & Holweg (2007) as supporting the creation of value and eliminating waste downstream in the value stream is the one used in this report.

Lean Consumption

Businesses provide solutions to upcoming problems and needs of customers in the market. The understanding of the whole process and creation of full value for the consumer is one of the first lean principles (Womack och Jones 2005a). The ability to develop capabilities which generate customer satisfaction by understanding the consumption and provision processes and

patterns is of essence to improve the performance of value creation. Womack & Jones (2005a) present lean consumption which target the minimization of time and resources customers put into transactions. The incentives to spread the lean principles into the provision and consumption processes is the increase proliferation of stock keeping units and the changing of market characteristics towards increased uptime. Establishing a supply chain which offers adapted and differentiated solutions creates value for the customers with fewer resources. Lean principles in the provision and consumption phase are presented by Hines et al. (2004) as the main elements of supporting a value-creating and waste-eliminating structure. Womack and Jones (2005a) have identified six principles which all support the objective of lean consumption. The first principle is to provide an integrated solution which solves the customers' problem. Second is to minimize the customers time for the transaction. Providing what the customer wants is the third lean consumption principle and the fourth is to provide what is wanted where it needed and at the right location. Timing and punctuality is essential in most businesses and therefore providing the product when it is a need for is the fifth principle. The last principle is to provide total solution to minimize the time and resources put in by the customer. Womack and Jones (2005a) summarize these principles as presented in Table 2.

Table 2 - Lean consumption principles (Womack and Jones 2005a)

Lean Consumption Principles:
1. Solve the customer's problem completely by insuring that all the goods and services work, and work together. 2. Do not waste the customer's time. 3. Provide exactly what the customer's want. 4. Provide what is wanted exactly where it is wanted. 5. Provide what is wanted where it is wanted exactly when it is wanted. 6. Continually aggregate solutions to reduce the customer's time and hassle.

These principles provide an insight to the importance of establishing an understanding and the benefits which organization could gain by using them. The lean consumption principles are universal and are applicable both for external and internal customers (Womack och Jones 2005a). This usefulness could be adopted within organization to improve the processes and the costs of taking things into possession.

Order Fulfillment

Fulfilling upcoming demands from the end-customers and providing solutions which create customer satisfaction is a high priority for the organizations. Lean principles emphasize that the customers' needs are triggering activities in the supply chain and pulling the product out of the value stream. The flexibility and simplicity which is also emphasized by Zylstra (2006) is referring back to the lean principle pull and minimizing waste of overproduction and obsolescence of products. An important aspect when creating the supply chain network and its

capabilities is to reflect upon relation between costs of lost sales and costs of stock keeping. Fischer (1997) presents a model for determining an order fulfilment strategy. This model which is known as P:D model determine the relation between the product lead time through the supply chain (P) and the willingness of the customer to wait for the product (D). According to this model, establishing an inventory to cope with the variability in demand and the time of replenishment from the supply chain is important to achieve customer satisfaction. The customer satisfaction is depending on the order fulfilment strategy. Womack and Jones (2005b) have identified and characterized the automotive market as a differentiating business. A differentiated order fulfilment is an approach more suitable to generate value for the customer and use fewer resources. This strategy is also emphasized by Hines et al. (2004) which differentiate itself from a one-size-fits-all strategy which causing inefficient use of resources and create barriers within the system.

Flow in lean distribution

In order to achieve leverage in the understanding of customers when it comes to lean consumption and highlight value creation in downstream distribution, organizations should create a structure which enforces flow. Jones et al. (1997) have identified three major flows; material, information, and financial. These three are supporting the lean principles and the order fulfilment strategy.

The material flow is the physical flow of products which comprehend receiving, storage, and transportation of products. The information flow is the use of demand signal moving downstream upwards to pull product from the supply chain. The information flow uses computer system with visualization tools based upon lean principles to create instant feedback and information (Jones, Hines och Rich 1997). The last flow is the financial flow which is the decision point or gatekeepers and steer and control the flow along the value stream. Creating a system and structure must have the three flows as the main determinant to evade bottlenecks. Taken the material, information, and financial flow into consideration to create a system which is flexible and adaptable to changing requirements the system could use fewer resources and improve the value delivered to the customers (Jones, Hines och Rich 1997, Zylstra 2006).

Conflict in lean distribution

In the past the focus and resources have been spent in the manufacturing operations to cut costs and improve the solutions. The trend of outsourcing and focusing on the company's core competences highlighted the need for closer collaboration with suppliers. The incentives are the high level of value contribution from suppliers and increase awareness of supply chain competitiveness. During the last two decades the potential of competing with the distribution networks for improvements have become more central to provide value to the solutions (Zylstra 2006). The challenge for organizations and supply chains is to identify conflicts and areas which are constraints for further improvement. The lean distribution strives to connect the fluctuating demand from the customers with the manufacturing operations. This creates a

situation when the demand signal is determining the takt-time for production. However, since this will cause fluctuations in supplying schedules the challenge is to decouple or handle the signal to create stability and levelling in the production operations.

The strategy and approach to these conflicts between the distribution and production operations are discussed by Reichhart and Holweg (2007). By developing capabilities in the order fulfilment strategy and the order processes, organizations can achieve a levelled demand in the manufacturing processes. One initiative is to improve the customer relationships and analyze the need and behaviour from an aggregated level.

Another conflict is the objectives which aim at increasing the sales and the market share. These incentives facilitate behaviour of pushing products on the market (Reichhart and Holweg 2007). Therefore it creates a contradiction between the sales organization and the distribution of product according to lean principles of pull and flow. These contradicting objectives between different functions further emphasize the need for a more process-oriented organization favoured by Womack & Jones (2005b). Creating these sub-optimizations in isolation is increasing the costs of flexibility in the manufacturing operations but also costs of inventory in the distribution channels.

4. Case description

In this chapter the data collected from conducted interviews and VP's internal documents will be covered. The research illustrates and describes VP internal supply chain and investigates the perception and opinions about the logistical flow, supply chain, and lean. The data collected in this chapter particularly supports the understanding of how lean principles could be used in an automotive aftermarket context. The chapter will outline the VP spare parts distribution with focus upon the European market. The structure is presented and describes the actors, activities and the material, information and financial flows. This case description will act as a basis for the following analysis.

4.1 Volvo Parts Supply Chain

In order to be able to fulfill the customers' demand of spare parts, VP has created a supply chain to secure the availability of the parts at customers' locations. The term customer hereafter refers to dealers/dealerships while the end-customers are perceived to be the customers of the dealers. VP supply chain comprises different nodes all around the world including several central and support warehouses. While the central warehouses are supposed to cover the whole range of stocked parts, support warehouses are the means for securing smaller range of parts closer to the customers. The configuration of VP's distribution network is the result of many different factors such as the characteristics of demands, the constraint of financial resources and the market share of the company in different regions. Although different characteristics of the market in different region has made some adjustments in the configuration of the supply chain inevitable, the general supply chain structure is designed as illustrated in the below figure (Figure 3). VP serves different needs of the dealers through differentiated flows in the supply chain. This differentiation distinguishes the high frequent parts from the low frequent ones. It also considers a separate flow for the emergency orders.

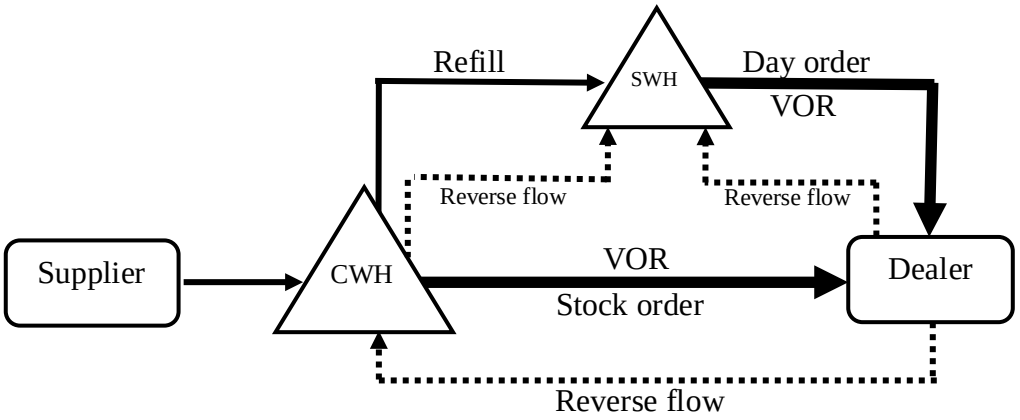

Figure 3 - Volvo Parts supply chain

The three main flows in VP supply chain are stock order, day order, and Vehicle Off Road (VOR) flow (The thick arrows in Figure 3). VP has 15 000 distribution points around the world. A significant share of these distribution points has a logistics agreement with VP in which VP takes the responsibility of refilling their inventory by the most frequent parts. The stock order flow is intended to achieve this goal. Therefore, the stock order refills are sent to the dealers from the central warehouses on a weekly basis to ensure the availability of the most needed parts. VP strategy to meet the demand of the high frequent parts with highly fluctuated demand patterns is to store them closer to the end customers. Consequently, the day order parts are stored in the support/regional warehouses in order to reduce the delivery lead time as well as costs of distribution to the customer. In addition, VP introduced a third flow of parts to the customers called Vehicle Off Road (VOR). Through VOR orders, VP guarantees to deliver the needed parts to the customer in case of accidents which keep the vehicle off the road. The parts needed in VOR flow are sent to the customers as soon as possible through express deliveries. The VOR parts are distributed from the support/regional warehouses. In case the parts are not available, the request is forwarded to the central warehouse. Moreover, the support/regional warehouses are refilled with parts daily by the central warehouses. Table 3 illustrates the different order classification in the aftermarket. As one goes down in the table the urgency of the delivery decreases and consequently the delivery lead time increases.

Table 3 - Order classification and their respective lead time

Delivery Lead time	***Order Class***	Type of flow
Increase in lead time ↓	Class 0	Vehicle Off Road (VOR)
	Class 1	Day order for the dealers
	Class 2	Day order for the importers
	Class 3	Stock order for the dealers
	Class 4	Stock order for the importers

The distinction between the dealers and importers in the above table relates to the separation of the support and regional warehouses. As mentioned earlier, VP serves its customer through different channels. Therefore, depending on the markets, it has support or regional warehouses around the world. The difference between the support and regional warehouses are in the size of the warehouse and the parts they stock. Regional warehouses which mainly exist in North America and International region are larger than support warehouses. In addition, stock orders are also sent from the regional warehouses while the support warehouses are only for the day orders and VOR. The other reason for the existence of the regional warehouses is the large

distance between the central warehouses and the customers in specific areas. This necessitates the existence of large warehouses for the consolidation purposes.

Considering the support and regional warehouses, the dealers are the interfaces between the support warehouses and the end-customers while the importers are the link between the regional warehouses and the dealers. Since the scope of this project only covers the European market where only the support warehouses exists, the regional warehouses are not discussed here. In the above table, the order classes 0 and 1 are delivered through the support warehouses while the order class 3 is sent to dealers directly through the central warehouse.

Similar to the other aftermarket supply chains, VP supply chain should also deal with the reverse flows. The reverse flow in VP supply chain can be classified in two different categories. One stream of the flow is created in the supply chain due to the quality issues and potential mistakes, while the other stream is due to VP policy towards the customers. VP has an agreement with its dealers, known as the Logistics Partnership Agreement (LPA). One of the sections of this agreement states that VP accepts to buy-back the unsold parts from the dealers under certain conditions. The reverse logistics and LP agreement are further discussed in later parts of this section (section 4.4.2).

In addition to the material flow in the supply chain, there also exist information and financial flows which are managed by the different departments within VP. These departments which are perceived as VP's internal supply chain are illustrated in Figure 4.

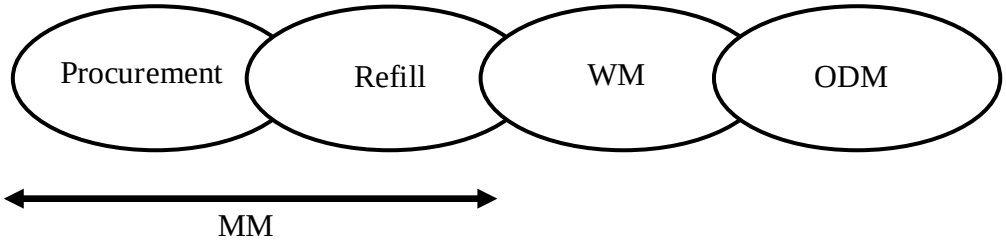

Figure 4 - Volvo Parts internal supply chain

VP's internal supply chain consists of three different departments, namely, MM, WM, and ODM. MM and ODM departments are dealing with tactical decisions such as setting up policies for procurement, refill and stock order flows as well as the distribution systems. WM on the other hand, takes the decisions on the processes and resources in the warehouses which correspond to the operational level of decision taking. MM department is divided into two sections, procurement and refill management. The procurement division mainly works with the suppliers and sourcing of the parts at the same time as the refill management focuses on the refill flows to the support warehouses and dealers' inventories.

Since this report has its focus on the VP internal supply chain, the following sections are dedicated to the empirical data collected during the data collection phase and describe the role and activities of each department in the supply chain.

4.2 Material Management

In this section the MM department is presented with its main activities and objectives in the logistical flow. It provides a deeper understanding of the interaction with suppliers as well as how resources are allocated and under which prerequisites and goals the decisions are based upon. The section hence, starts with describing the policies regarding the inventory management and continues by the replenishment and forecasting policies. The final parts of the section cover the suppliers and transportation.

4.2.1 Inventory Management

The main activities and resources in the MM department are directed to develop and manage the availability and flow of parts to the warehouse. These activities cover the interaction with suppliers and transportation of parts to the warehouses. The objective is to provide availability in the distribution system which means that the product should be at the right place, quantity and time. Decisions like these are critical to provide uptime for end-customers and ensure profitability. Uptime is defined by VP as providing the end-customer with a solution which increases the hours for trucks, buses, construction equipment, etc to be operational. To make these decision VP have established routines and policies to act upon parts volume and frequency. These policies consider the divergent distribution, consumption, and costs patterns of the widespread parts range.

One of the main performance indicators for the MM is turnover rate of inventory. The turnover rate is often used as a financial measurement to show the performance in the whole distribution network but also in the different nodes. Measuring is often based on an aggregated number of parts ranges and together with the availability measurements is used to evaluate the performance of the operations. The other indicator used in MM is the service level. Service level is defined to measure the percentage of the average orders lines supplied in each order. Orders are divided into order lines and each order line indicates the needed amount of one part. Therefore, the service level measures the completeness of an order on an aggregated level. Table 4 depicts the main key performance indicators (KPI) in MM.

Table 4 - Main KPIs in material management

KPI	***Calculation***
Turnover rate	Cost of goods sold/ Average inventory
Service level	(Order lines fulfilled in an order/ Number of order lines in an order)*100

In VP's logistical flow several critical decisions are based upon policies and use the forecast as input for executing activities such as replenishment, stock levels and safety stock. The first

decision is whether or not a part should be stocked which is determined by the parts classification based upon the yearly demand and value. The yearly demand of the part is defined as the number of order hits in the system during a specific time window. An order hit occurs when a customer order is created in the system. Moreover, the value of the parts is determined in price intervals. What VP uses is a two-dimensional matrix which identifies both the yearly demand and the parts value.

The support warehouse stock holding policies at the moment indicate if the parts are active (and hence stocked) or passive in the warehouse assortment. In this case the number of order hits registered for the parts in the warehouse during a certain time period is the basis for the judgement. When the parts are categorized as passive, they are also placed under investigation of returning to the central warehouse, placing it in passive parts storage or scrapping it directly at the support warehouse.

4.2.2 Replenishment

In order to replenish the inventories in the distribution nodes, VP applies reorder points. The reorder point is determined as a trade-off between replenishment frequency and the safety stock. The safety stock is based upon the uncertainty in the forecast and fundamentally the forecast error. The order size is determined by the economic order quantity (EOQ) which is adapted to the classification rules based on the yearly demand and value described previously. Combining the EOQ and the safety stock, these provide information to determine the level of inventories in the distribution nodes.

In the replenishment cycle, the reorder point is set based upon two factors: lead time (from the time the replenishment order is placed until the inventory is replenished) and the demand from the customers. Volvo has defined this lead time from order to available in stock into three parts which together affect the inventory levels in the warehouse. The first is internal lead time at the supplier referred to manufacturing time, second is transportation lead time and the third is parts receiving lead time (Figure 5, p. 36).

In MM there are no standardized procedures for updating the lead times and it is more handled in the supplier relationship through the supplier evaluation process. From the MM side there is a desire in establishing agreed lead times towards the suppliers. However, since the system has difficulties to change the lead time, there is a high degree of human intervention in case of problems and other activities which affect the lead time. These problems include the situations when there are break downs or the suppliers have delivery problems. MM approaches these problems from two fronts by establishing supplier delivery precision program and including a buffer lead time for the uncertainty in the incoming flows from suppliers.

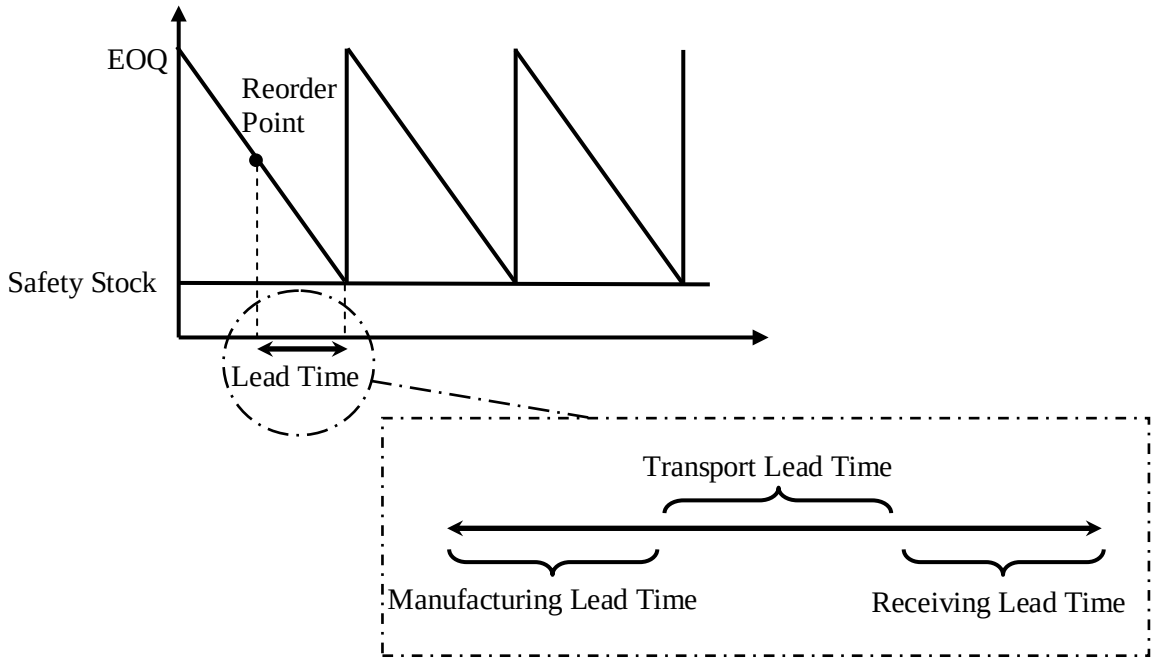

Figure 5 - Replenishment at Volvo Parts

4.2.3 Forecasting

Forecasting plays a significant role for VP through providing information for replenishment and allocation of parts in the distribution network. The aim is to foresee the parts consumption patterns by the customers in the different nodes in the distribution network. Due to the proliferation of parts in the system and a high degree of low frequent parts with erratic demand behaviour at the dealers the demand is consolidated into the forecasting process. Consequently, the forecast is done in the local markets and then transferred to the central warehouse in Gent. In Gent an aggregated forecast is generated. This forecast is then used to estimate the consumption patterns and determine the time when it hits the safety stock (Figure 5). Further, it will help to set the delivery schedules (described later in this section) and send it upstream to the suppliers. The uncertainty in the forecasting process (forecast errors) is monitored to maintain the forecast accuracy and to create signals if the error is exceeded from a certain level.

In order to communicate the customer demand with the suppliers, VP is developing a delivery schedule for the forthcoming 52 weeks. The delivery schedules should be seen as a plan for the suppliers determining the volume and mix of parts. This plan is updated every week and specifies the final schedule of deliveries for that specific week. The schedule for that week will not change afterwards. The problem is that the system only handles weekly demand which means that the replenishment must occur the week before actual date of replenishment is needed. In this way the system replenish parts up to two week before the actual needed delivery. The plan is divided up into different time fences (Figure 6) to provide the supplier

with time to allocate resources and plan the production. The first is the frozen period which is a minimum of one week depending on the part and supplier characteristics. Another time fence is the order balance which is the latent demand communicated in the delivery schedules which state forthcoming needs in volume but with no information of mix or the time volume is needed. The delivery schedules are based upon the aggregated forecasts from the dealers' statistics and the current stock levels in the central warehouse. However, the stock level situation in the support warehouses is not taken into consideration when the delivery schedules are conducted and there is no communication of the needs from the support warehouses.

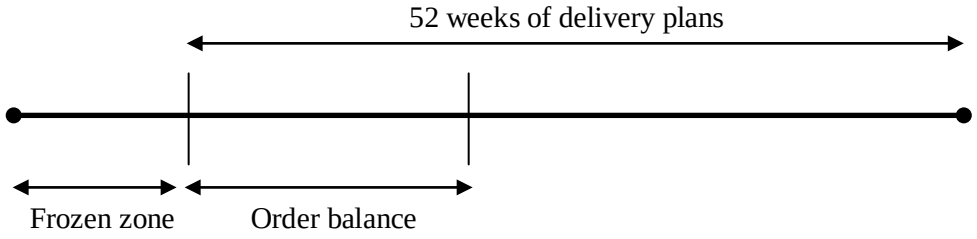

Figure 6 - Delivery plan's time fences

4.2.4 Suppliers

VP interacts with around 6000 suppliers, 1000 of which are considered as the major ones. The relationship with suppliers is base on both arms' length and high involvement relationship. The main aim is to ensure capacity and stability in the lead times and hence create availability in the distribution network. The decision of sourcing parts is to high extent made by the business units. The influence from the aftermarket business unit is historically limited due to the focus towards the manufacturing business. In this respect, VP attempts to contribute with input and feedback to ensure the voice from the aftermarket business. After the economic crisis 2008 the sales have increased for both production and aftermarket which put pressure on suppliers to increase capacity. The increased volumes and new capacity create a situation where there is an internal competition between VP and the business units' production. This competition has become more significant since VP and business units send their orders to the common suppliers separately. In this respect, there is a lack of coordination and synchronization between VP and the business units and the suppliers' behaviour of prioritization is not a discussed issue.

The proliferation of spare parts and shorter life cycles also creates suppliers which solely provide spare parts to VP. This accounts for up to 50 percent of all supplying companies. In the previous setup, VP had one material planner per business units responsible for communicating the spare parts' needs with the supplier. This created problem with utilizing the strength of VP as one organization. Therefore, VP has introduced a global material planner responsible for the interaction with the suppliers. In addition, the assessment of suppliers' performance is monitored through Volvo Supplier Base.

4.2.5 Transportation

The transportation solution in the inbound logistics is outsourced to Volvo Logistics according to the Terms of Delivery. The role of VP is a coordination role which handles the interaction between the transport provider and the suppliers. The target is to identify milk run opportunities and thereby increase fill rate to create full truck loads (FTL) in transportation from the suppliers to the central warehouse in Gent. These opportunities are identified through the collaboration between VP and Volvo Logistics. The milk run transportations affect the suppliers to deliver parts according to quantity and time restrictions but due to VP's delivery schedules are based upon weeks it have no effect upon availability at the warehouse. The milk runs serve the purpose of consolidating transport from suppliers and from the warehouses and thereby minimizing the cost and the environmental impact both on local, regional and global levels. These solutions also minimize the congestion in the nodes terminals which affect the receiving operations.

4.3 Warehouse Management

The following section provides all the data collected at the company in relation to the WM and its interaction with other departments in VP's internal supply chain. The section first starts with presenting general facts and figures about the configuration of Volvo's spare parts warehouses followed by exploring the operation in the warehouse from a more detailed perspective. However, since this project is only focused on European region and specifically considers the flows related to Volvo Trucks, Buses and Penta between the Gent central warehouse and European support warehouses, this section will neither investigate the warehouses outside Europe nor the interactions between the support warehouses and the other central warehouses in Europe apart from Gent. The sources of the data provided in this section are the interviews with the related managers at VP and two warehouse visits at Gothenburg's support warehouse conducted during the data collection phase.

4.3.1 Warehouse Design

VP, with more than 32 million orders from all over the globe each year, runs one of the world's largest logistics systems. It provides parts for all its customers through 42 warehouses located in three main regions, namely, Europe, North America and International region consisting of some parts of Asia, Australia and South America. These warehouses provide aftermarket services to all different Volvo group business units and are classified as central warehouses, regional warehouses and support warehouses according to their size and the order classifications for which they provide support. Volvo has a total number of five central warehouses, three of which are located in European region; Gent, Lyon and Eskilstuna. While the warehouses in Eskilstuna and Lyon provide parts for Volvo Construction Equipment and Renault Trucks respectively, Gent warehouse is responsible for Volvo Trucks, Volvo Buses and Volvo Penta spare parts. There also exist nine support warehouses in Europe which mainly deal with the day orders and VOR orders. The main reasons for positioning the

support warehouses in general include creating quick support to the dealers, providing a part range according to the stock holding policy, saving transport costs, and increasing the service level. Figure 7 shows an overview of the Volvo warehouses which deal with the trucks, buses and Penta spare parts and maps their location across the globe.

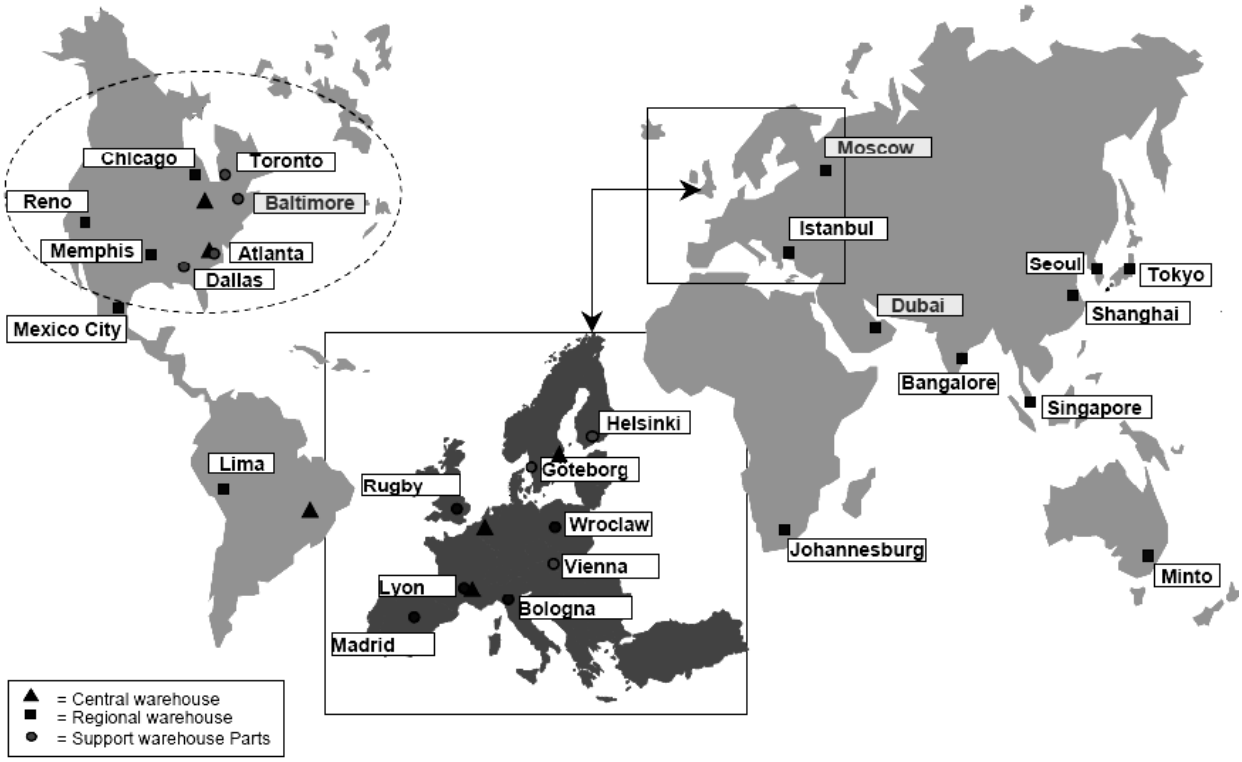

Figure 7 - Volvo warehouses dealing with trucks, buses and penta parts

The warehouse activities have previously been handled individually at the separate warehouses. A new department, WM, has recently taken the responsibility of developing global processes. WM is currently responsible for the design of the processes in the warehouses and to ensure the synchronization and coordination between them. It is also responsible for the performance measurements in the warehouse operation and investigating the possible areas of improvements.

4.3.2 Warehouse operation

The operation in the warehouse can be defined into two different flows, inbound and outbound flow. The inbound flow includes activities needed to be done when the parts arrive at the warehouse gate and the outbound flow covers the process performed related to order fulfillment until the parts are ready to be shipped to the customers depending on the type of the warehouse. Although general policies related to the activities done in inbound and outbound flow are similar in both central warehouse and support warehouses, the different nature of the incoming and outgoing flows makes some adjustments in operation necessary. Hence this part of the report deals with the central and support warehouse separately.

Central Warehouse

The inbound and outbound material flow in the central warehouse are as depicted in the below figure (Figure 8). It consists of the arrival of goods from the suppliers, the delivery of goods to the support warehouse and dealers and the arrival of the goods in the reverse flow from the dealers. Due to the size of flows to/from the warehouse two separate management teams take care of the inbound and outbound flow in the warehouse.

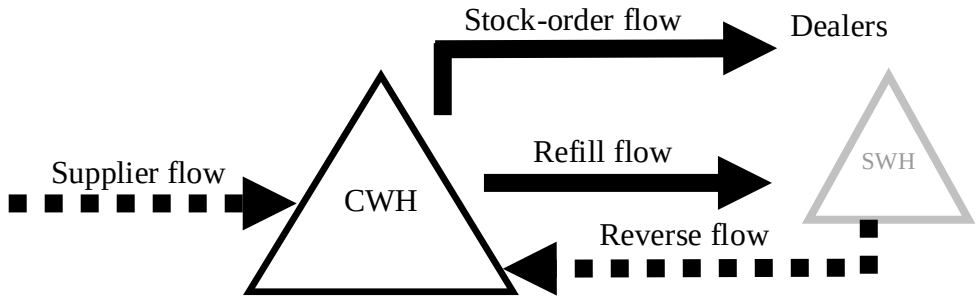

Figure 8 - Flows in the central warehouse

The inbound flow starts from the point when the parts arrive at the warehouse gate. The material flow to the warehouse is divided into two groups, supplier flow and customer flow (reverse flow from the dealers/support warehouse to the central warehouse). In the supplier flow there are up to five steps before the parts are ready to be binned. These steps include unloading, receiving, repacking, quality control, pre-packing and binning. However, not all the parts need to pass through all the steps before binning. This is especially true for the quality control. Due to the fact that many suppliers are running different types of quality certifications such as ISO, the quality control is not necessary for all the parts. In this respect the supplier flow at the warehouse is divided into stock-and-handling and dock-to-stock flows with two different teams working with them. The fast-lane flow which is managed by the dock-to-stock team, are the type of parts which can be immediately binned after receiving. The quality check is usually done for all the new parts and a random sample of parts related to the suppliers with deviations and only includes visual controls to confirm if the part is sent correctly.

Since the delivery schedules of suppliers are set only on a weekly basis, prior to the goods arrival at the warehouse Advanced Shipping Notes (ASN) are sent to the warehouse so that the warehouse be able to pre-plan the resources and manpower. In addition, reports generated by the system determine the activities and the flow for the parts delivery. However, as a result of the weekly schedules, warehouse normally experience arrival peaks on some days during the week. These peaks mainly occur around noon and especially on Thursdays. After the goods' arrival and unloading, the parts information is registered in the system and the parts are considered as received. There are eight receiving areas at the warehouse in order to reduce the waiting time for unloading and receiving activities.

The binning activities are classified based on the binning areas and the equipment needed for binning. The binning policy is based on batch binning where the similar parts (according to the classification factors) are binned together. All workers in the warehouse use a standard method for binning. However, the only tool used to prevent the binning errors is visual check. The scanning control tools are only used when the goods are received. Another issue within the binning process is the congestion created as a result of binning process. There exist some optimizations in order to reduce the congestion in the inbound flow. These optimizations, however, only covers the inbound flow and there is little coordination with the outbound flow in this respect. When talking about the binning process, an especial flow can be recognized in the warehouse called prioritized flow. The prioritized flow which is prioritized in binning in comparison to other parts could be referred back to back-orders or low safety stock in the warehouse. The target for binning the prioritized flow is to perform the binning process within one day after the part is received. Nevertheless, the current figure for the target is 80%.

The activities performed in the other material flow to the warehouse, customer flow, are slightly different from the supplier flow. Customer flow or the reverse flow to the warehouse consists of three main types of flow, return flow, buy-back flow and refill returns. The return flow includes all the goods' returns to the warehouse due to errors such as wrong parts or quantity and damages. Buy-back flow is the reverse flow from the dealers with parts originated from stock orders. This occurs when the parts sent through the stock orders are not sold. Refill returns refer to the flow of parts from the support warehouses for which there have become passive due to lack of order hits. When receiving the customer flow, the parts are divided into two groups; the ones which should be scraped and those which need to be binned again. Quality inspection should be done for all the parts which are not going to be scrapped. Due to the considerable amount of verification and administrative tasks needed to be done in the customer flow, this flow causes waste and more handling.

The outbound flow at the warehouse includes activities related to picking, packing and shipping. This generally covers the refill flow to the support warehouses and stock orders to the dealers (Figure 8). Since the major costs in the warehouses is related to the picking process, the central warehouse divided the warehouse into two different sections, i.e. reserved and forward (golden zone) area. The parts with frequent demand are stored in the golden zone which is closer to the shipping gates in order to reduce the travelled distance for the pickers. The reserved area, on the other hand, is dedicated to the low frequent parts and a portion of the high frequent parts in case the golden zone is full. In the later situation, the golden zone is then fed by the reserved area. The picking policy in the warehouse is batch picking and the parts will later be sorted manually. The prioritized flow in the outbound flow is the day order picking. This normally occurs when the parts are not available in the support warehouse. In that case the support warehouse sends a request to the central warehouse, known as split-order. The split-orders which are supplied from the central warehouse in case of the availability problems in the support warehouses can cause disruptions in the stock-order picking.

The metrics used in the warehouse are based on the productivity (speed of operation) of the blue-collar workers and the number of errors. The productivity metrics are further used as a tool for evaluating the allocation of the resources. There are also some follow-up metrics such as number of goods needed to be re-pack, number of fast-lane goods and percentage of suppliers using EDI systems. However there is no structured measurement for internal quality in the inbound flow. The VPS terminology has introduced problem solving methods such as 5-why analysis, quick response and quick control to the warehouse. Nevertheless these methods are only applied in pilots at the moment and are not commonly used in the warehouse operation. The number of errors in outbound flow is measured using two different metrics, wrong pick and nil pick. The nil pick happens when the bins from which the parts should be picked are empty. A summary of the metrics used in central warehouse along with their calculation method is presented in Table 5.

Table 5 - KPIs in central warehouse operation

KPI	***Calculation Method***
Productivity	Number of lines picked/blue collar hours
Number of wrong pick	Number of times worker picks the wrong part
Number of nil pick	Number of empty bins when the picking occurs
Follow-up	Number of re-packs required, Number of fast-lane goods, % of suppliers using EDI

Support Warehouse

The point of departure in describing the operations and processes in support warehouses is the support warehouse in Gothenburg. Similarly to the central warehouse, the activities in the support warehouse are also classified into inbound and outbound flow. While the general characteristics and features of the flows are virtually the same as the flows in the central warehouse, the elements such as the size of the flows and types of demands (orders) makes some distinctions in the processes of the support warehouse. The inbound and outbound flows in the support warehouse are demonstrated in the figure below (Figure 10). However, before going to the flows, the physical layout of the support warehouses is described in this section (Figure 9). The reason is both to provide a schematic presentation of the support warehouse and to illustrate the general policies of storage and retrieval in VP warehouses.

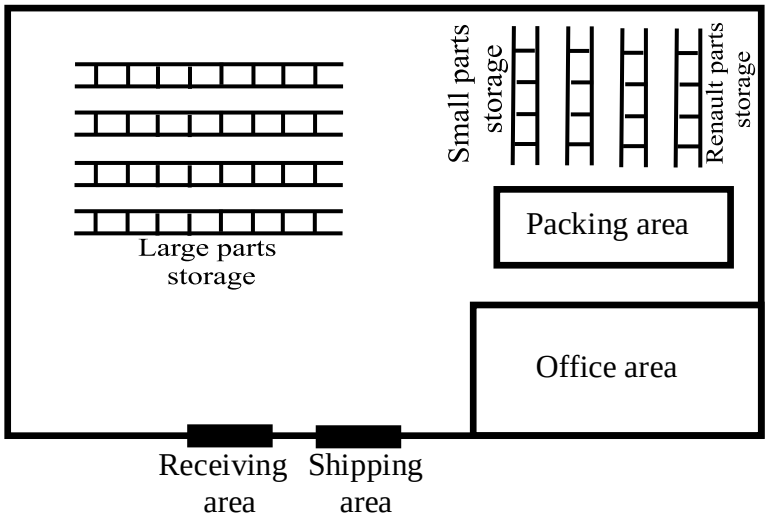

Figure 9 - Physical layout in support warehouse

The support warehouse is divided into several sections with a U-shape layout of incoming and outgoing gates. The sections stock the parts based upon the part characteristics such as weight and volume and the need for different picking equipments. However, this is the differentiation made between parts and there has not been any thorough analysis of demand and frequency or such done regarding the parts segmentation. The sections are further divided into aisles and shelves and the high frequent parts are stored at the lower levels while the low frequent parts are on the higher shelves. The parts in the shelves are kept in pallets and boxes of different types.

There are two layouts in the warehouse, one related to the Renault's small parts and the other one for the rest of the parts. Some lean improvements have been done in the Renault section which is expected to be also expanded in other areas of the warehouse. As an example, it can be referred to the rack orientation and identification. Additionally, in the Renault section exist barcodes for identification of the parts while in the other sections of the warehouse the

identification is only limited to the shelves and not the different parts inside the shelves. The storage and retrieval system in the warehouse is based on using the barcodes and paper-based system. The warehouse does not have any specific structure for optimization of the slotting designs since the judgment and tacit knowledge of the employees is the only approach and there is little or no consideration of demand or frequency.

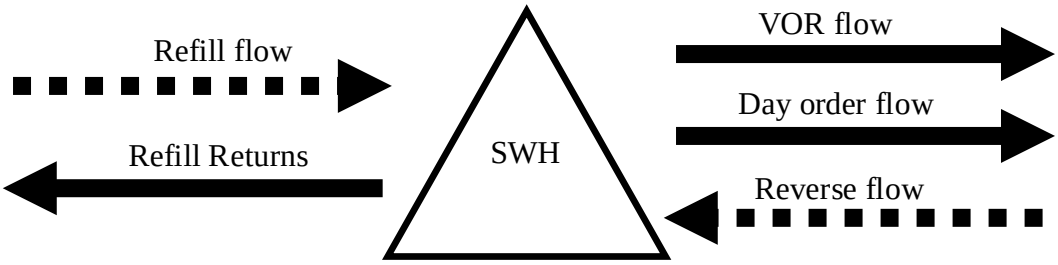

Figure 10 - Flows in the support warehouse

Support warehouse is responsible for supplying the day orders and VORs to the dealer. The inbound flow in the warehouse consists of the refill flow from the central warehouse and the reverse flow (dashed arrows in Figure 10). The reverse flow includes the parts which have been already ordered by the dealers but have not been used and hence are returned to the warehouse. Considering the refill flow, trucks are sent to the warehouse on a daily basis and with the lead time of two days. The parts are then unloaded in the warehouse and scanned into the system (receiving process). Next, the parts wait to be binned in the warehouse. The vision for inbound process is to do the related activities within the three hours. The reason is to prevent potential unavailability of parts during the picking process which is possible since the parts are considered as ready to be picked according to the system after the scanning process. However, since the peak time is after noon for incoming orders from dealers, the binning time can be extended unofficially until noon.

The receiving team normally spend 15% of their time on correcting the quantity deviations occurred by the central warehouse. The deviations normally occur as the parts missing, extra parts or misplaced parts. This can cause problems since the parts are seen as available in the systems after the arriving pallets are scanned. There are two different approaches for such problems. In the first case, the workers correct the deviation directly after the detection. In the second case, however, they will wait with reporting the deviation until the receiving process is finished. This later approach is used to minimize the time and effort on corrections. In addition, deviations such as missing parts are usually solved through finding the part in the next pallet.

The outbound flow, on the other hand, is more complicated in the support warehouse as the parts should be picked based on the erratic demand behaviour. The warehouse's strategy in this respect for the day orders is to set some restrictions in the ordering process. Hence, there is a cut-off time or the deadline for placing orders in the system. However, the warehouse will not wait with the whole picking process until then and the workers start picking before the

cut-off time. In this sense, for consolidation purposes, only the picking for large dealers starts after the cut-off time. The picking strategy has been recently changed from three different people doing the picking, packing and shipping respectively, to one employee doing the whole process for each order line. This has removed the communication and coordination problems existed before. The pickers select the orders manually and use order batching for 5-7 customer order in each round and do the sorting process later on. This sorting strategy can create a lot of additional work in the warehouses with majority of small customers with low-volume orders. For VORs, however, the warehouse follows a different strategy. VORs which should be delivered to the dealers as soon as possible are picked by the team-leaders and are sent to the dealers immediately.

In the case of unavailability of the part, two especial flows are recognized, namely, split orders and back orders. If the system cannot provide the part from the support warehouse the order is referred automatically to the central warehouse as a split order. In case of unavailability of the part in the central warehouse, the order will be categorized as a back orders and an estimated time of availability (ETA) is provided were its possible.

The metrics used in the support warehouse are similar to the ones in the central warehouse (Table 5). Both wrong and nil picks are measured to evaluate the picking accuracy. The productivity of the employees is another measurement used. Nevertheless, the measurement and understanding of the waste in the processes can be hard since the reporting is at an aggregated level and only on a quarterly progress. The current challenges of the support warehouse, according to VP warehouse managers, are mainly quality issues.

4.4 Order and Distribution Management

In the downstream flow VP emphasizes on providing a solution and network which ensure parts availability at the dealer and minimize the effort needed in the interaction between VP and the dealerships. In this section the distribution solutions and coordination mechanisms towards the dealers which are the main objectives for the logistical flow are presented.

4.4.1 Dealers

Dealers are the customers to VP which have the main focus to ensure availability towards the end-customers interacting with them. They handle repair and maintenance of Volvo products in repair shops and onsite services. There are differences in dealership structure in Europe. They are generally divided into interdependent dealers and those dealers which are owned by Volvo's respective business area. In some countries such as Spain, there are few big dealerships while the other countries such as Nordic countries are characterized by small and local dealerships. Dealer management at VP handles the ordering and receiving system which in turn supports and provides the tools and prerequisites for the dealers to create availability for the part range they keep in stock.

Ordering process is linked between VP and the dealers through Volvo Vision (VV) and Parts OnLine (POL) systems. These systems are the same, however, POL is a web-based one. These two are the interface for information sharing and order processing which involves ordering, invoicing and illustrating the availability in the different warehouses. The ordering process follows a strict hierarchical pattern determining which point in the network has the part available. The parts are normally delivered according to the order type and invoice is sent to Volvo Importer Parts System (VIPS) which is a regional system for the sales operation of the business areas. VP's interaction with the dealers could be seen as they provide the tools and logistical solutions for creating availability and dealer's close relationship is towards the business areas and the sales organization. The three systems used in ODM department are summarized in the below table (Table 6).

Table 6 - Automatic systems used in order and distribution management

Systems used in ODM	***Tasks***
Volvo Vision (VV)	Order Processing
Parts OnLine (POL)	Order Processing
Volvo Importer Parts System (VIPS)	Sales Operation

4.4.2 Dealer Management

The current setup is based upon a modified Vendor Managed Inventory (VMI) structure were VP establish the LPA (Logistics Partnership Agreement) and dealer inventory management (DIM). These are the main concepts and framework for dealer inventory management. The objective is to provide the dealers with knowledge and best practices to increase the sales volume and availability. The LPA together with the stock holding policy states the stock range and levels according to sales statistics and demand frequency. Creating an inventory at the dealers improve the availability towards the end customer and create prerequisites for allocating the parts at the right place in the right quantity. The DIM handles the stock orders previously described as a setup ensuring parts availability which is a trade-off to the distribution costs in day orders and VOR orders. The trade-off is to ensure a high level of customer satisfaction. Establishing the LPA creates a smoother consumption and less hassle in the inventory management for the dealers which the foremost goal is to serve their customers. Minimizing the activities linked to management of inventory and ordering towards VP release the dealers' resources and time to focus on the core business.

The stock orders are replenished from the central warehouse and use consolidated transports with milk runs out to the dealers on a weekly basis. Providing the parts directly from the central warehouse minimizes the number of parts handling occasions and the number of actors

involved. The day orders have another physical flow moving from the suppliers to the central warehouse which in turn refills the support warehouse. From a distribution perspective the day orders are handled by the support warehouse. This creates prerequisites for minimizing the cost of transport and fulfilling the communicated solution of high availability and uptime for the end-customers. The setup of day and stock orders together provide an aftermarket solution with high availability and efficient logistical solutions in respect to lead time and cost.

4.4.3 Reverse Logistics

The automotive aftermarket is to a high extent characterized by high uncertainty when it comes to volume and mix demand. Dealers operations have a challenge to determine the need for maintenance or repair of a vehicle and which parts should be ordered. VP ambition is to provide the dealers with a service which enable them to order parts in prior to the confirmation of the diagnosis. To create incentives to minimize the lead time for the customers and to avoid express deliveries VP provide a reverse flow for parts from the dealers.

Return flow is mainly divided into two sections; one is return of parts and one is for Volvo specific packaging. These flows are handled by the outbound transport solutions described earlier in the MM section. The reverse logistics creates the possibility for a closed loop by returning the packaging to the warehouses. The second flow of returns is the parts return to the central and support warehouses. Parts returns are categorized based upon policies which include buy-back, return and discrepancies.

Buy-back of parts is included in the LPA which handles the dealers' inventory of stock orders. The buy-back return flow is divided into windows during a year which allows dealers to return parts which meet the buy-back policies. Stock order inventory must have been determined as passive due to no demand during a consecutive year so that it can be considered for the buy-back flow. In addition, the stock value ratio in this case should be above a certain level. The buy-back flow is towards the central warehouse which influence the time periods available for returns of stock order inventories. LPA and buy-back and returnable policies create incentives for the dealerships to use VP systems and tools.

As mentioned earlier, return flows of part could be due to uncertainty in the need of parts from the dealers' side. VP allows dealerships to send back order within certain time after they have been ordered. In this flow the parts are entered into the return logistical flow and shipped to the facing warehouse.

The last flow of returns is often caused by quality issues which are related to discrepancies in the system. This includes; wrong part, damages, quality issues, quantity, ordering mistake. These returns are a highlighted area at VP organization to find the root causes and apply counteractive measurements to minimize and eliminate it.

5. Analysis

This chapter presents the analysis based on the literature study and the case description. Due to the characteristics of the report, it has been decided to organize the analysis section into two main parts. Therefore, the first section of this chapter is allocated to the analysis of applicability of lean in the aftermarket environment. Moreover, the focus in the second section is on VP and the investigation of how the VP's processes meet the requirements of employing the five lean principles. In this respect, the analysis is conducted around the lean principles and in each sub-section the three VP departments (MM, WM and ODM) are analyzed. Figure 11 presents the structure used for the analysis.

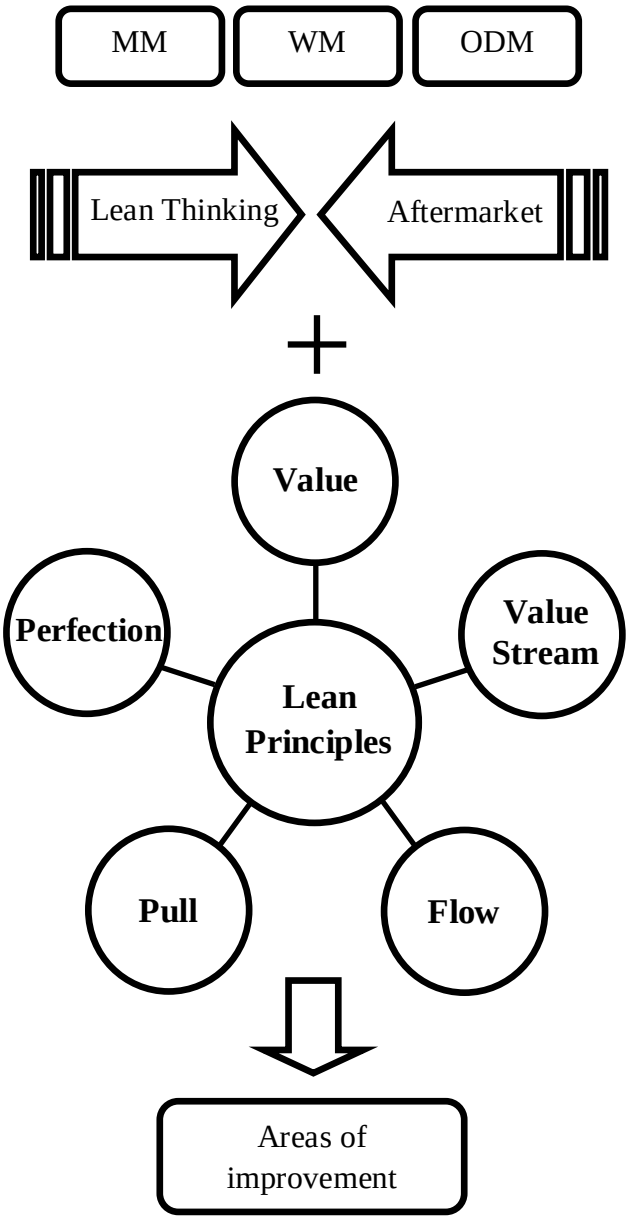

Figure 11 - The structure used for analysis

5.1 Lean Aftermarket

Talking about aftermarket characteristics and trying to apply lean principles in its unique environment, raises the question of whether or not the lean aftermarket is relevant. As mentioned in section 3.2.1, lean thinking has initiated in a mature stable market with high volume and low variety. Nevertheless, the aftermarket business is known for its fluctuated volume and high variety. The demand in the aftermarket is highly unpredictable which highlights the necessity of being responsive. This mean despite what Womack and Jones (2003) suggest in fourth lean principle (pull) about the application of make-to-order strategy, the companies working in the aftermarket cannot wait for the customers' order signal before they start producing. The aftermarket characteristics and order fulfilment strategy with longer product lead time than customers' willingness to wait suggest a need for pushing the parts in the distribution nodes closer to the customers as pointed out by Fisher (1997).

At the same time, the proliferation of the spare parts makes the situation more complicated. Lean perspective which bases its third principle on a smooth and continuous flow of parts in the supply chain might create difficulties for the companies to support the low frequent parts. Companies normally prefer to keep the fast moving parts in their inventories to ensure their ability to make profit. However, as a result of the high competitive market on the fast moving parts, companies can achieve benefits by taking the slow moving parts market share as a total solution provider (Womack and Jones 2005a). In this situation it would be hard for the companies to create a continuous flow of small batches in their systems.

On the other hand, due to the different needs and expectation of the customers which creates different characteristics for the parts in terms of demand frequency, companies should serve their different customers through differentiated solutions. Not all the customers expect the same value from the companies. Therefore offering one solution to all of the customers gives extra service to some of them while keeps the other ones unsatisfied. In addition, the one-solution-fits-all strategy imposes extra costs to the company. Lean thinking supports the idea of service differentiation and creating the value as the customers needed. As Poppendieck (2002) also points out, lean thinking is about creating value for the customers with the minimum resources possible. Differentiating the solutions for the customers assists the companies to keep all the customers satisfied.

Lean thinking is all about creating value for the customers. Moreover, the fundamental purpose of developing the aftermarket is to support the customers after the sales and keeping them satisfied. Phelan et al. (2000) also points out that maintaining the links with customers and fulfilling their needs after the sales is as important as marketing for finding new customers. This is true since the costs for finding new customers is generally higher than investing on the existing ones. This is totally aligned with the lean principles where it mentions focusing on the customers and setting the companies goals based on what creates value for the customers.

Since the markets are developing and so does the customers' demands and expectations, the organizations need to increase their knowledge and awareness to have a clear strategy to meet this change. There exist two recent trends in the markets. First, is the shift in the organizations from offering products to offering a differentiated solution and secondly the transition from selling products to providing services. The shift allows offering differentiated solutions to the customer where the benefits are maximized by using fewer resources (Figure 12). For the aftermarket, there are opportunities to further understand the customers. This view is also supported by the work of Herbig and Palumbo (1993). The first lean principle, value, highlights the importance of understanding the customers and their needs in order to develop the capability within the company in offering competitive solutions. By cooperation between different actors in the supply chain the organization could find synergies and avoid sub-optimization. This is fully in line with Phelan et al. (2000) that points to the increased number of solutions and services in the aftermarket.

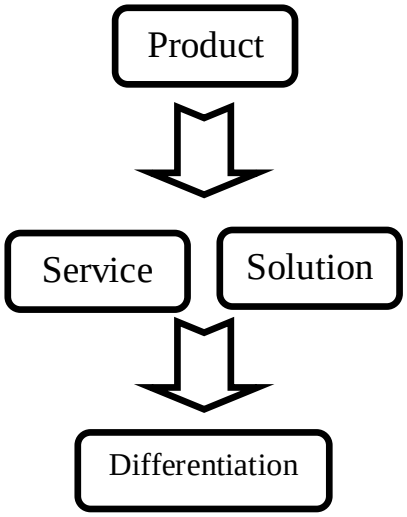

Figure 12 - The transition towards services and solutions

Distribution in the aftermarket differs from the distribution in the production environment. The network is more widespread and there is a need to create robust flows that can handle large differences in the volume and type of cargo. In order to make use of lean principles, organizations must configure a distribution network which supports the availability of right products in the right location. Large and extensive networks are more sensitive to disturbance and therefore the lean principles can help to reduce the stops in the flows and bottlenecks in the system. It can also further prevent the secondary problems which are the result of the stoppages and bottlenecks.

The reverse flow is an important part of the market and its operations. Hence, in addition to the widespread distribution network with wide variations in flows, as explained earlier, aftermarket should also consider the reverse flow. This which accounts for up to 20% of sales (Daugherty, et al. 2003) highlights the importance of organizations' performance in this area and is a determinant factor for a company's success in the aftermarket. In this perspective, the

pull principle is one way to go in order to influence the flow of products. It advocates a system where all needs are controlled by a customer order and thus there is always a receiver at the end of the chain. For the aftermarket, there is a great value for the customer to increase uptime. Similar to all other flows, it is of utmost importance to reduce reverse flows which are traced back to the quality issues or other abnormalities.

Aftermarket today is characterized by a supplier base that is divided into two groups. One group is the suppliers providing parts to both the production and the aftermarket. The second group are those suppliers that are either only focused on the aftermarket from the start or have shifted their focus from delivering to the production toward the aftermarket. The first group of suppliers can be difficult for the market to create a mutualism relationship with since their focus is spread between two markets and they might not be able to prioritize it. The difficulty for the suppliers could be the fluctuating demands of aftermarket which is in contrast with the smoother and stable flows from production. It is therefore important to create good flow which reduces the problems of self-induced fluctuations in demand.

5.2 Lean Volvo Parts

Coming this far in the report and after investigating the applicability of lean in the aftermarket environment, this chapter is dedicated to a closer look at VP and evaluates the application of the lean principles specifically in this company. To structure this section, the operation of each department in VP is analyzed through the lean principle lenses and a final section in each part is devoted to the investigation of the principle in the whole internal supply chain.

5.2.1 Value

From the lean perspective, defining value in the supply chain necessitates consideration of the process from the end-customers' point of view. In this respect, examining VP end-customers' perspective upon the availability of the right parts in the right time, right place and with the right quality is important to achieve customer satisfaction. Furthermore, it is critical for VP to set this goal as the ultimate value of the organization and strive to align all the activities and processes with it by communicating the value with all the actors in the supply chain. Consequently the three departments within VP internal supply chain need to fulfil the mentioned value through their processes. This section first examines the extent to which each department is aligned to the end-customers' value. Then it looks at all departments together and tries to capture a holistic view of how the whole organization looks upon the value and pinpoints the problematic areas.

Material Management

As mentioned earlier, the main goal in the MM department is to ensure the availability of the parts in the system. Theoretically, such objective seems to be fully aligned by what is perceived as value by the customer. However, the next question is how the activities and measurements in the department practically support such goal to be achievable. MM is

responsible for the policies regarding the replenishment and hence has a key role in securing the parts availability as well as the company's inventory turnover rate.

In the environments with high degree of demand uncertainty, basing the procurement and replenishment decisions only on statistical forecasts makes it hard to cope with the fluctuations in demand and ensure the availability. Setting the parts' availability as the major objective of the department obliges MM to ensure the forecasting precision. As (Cohen, Agrawal and Agrawal 2006) also point out, in the markets with unpredictable demands, mathematical forecasts methods and delivery schedules should be only a tool to predict the possibilities for distributions. Using forecasting as the only method for making decisions in VP with limited influence of the material managers affects the availability negatively.

Furthermore mismatches between the demand and supply which is one of the consequences of deploying mathematical forecast methods only, amplifies the instabilities in the delivery schedules and further creates serious problems for suppliers to react to the delivery schedules. Developing the delivery schedules based on forecasts for 52 weeks with short-span frozen zones and using the order balances later as a leverage to prevent excess inventory in the system, can send the suppliers mixed signals and affect the availability afterwards.

At the same time a long and instable lead time which is a result of bottlenecks in the processes both in warehouse operations and at the suppliers creates instability of the delivery schedules and influences the parts availability to a great extent. The instable lead time which is used as one of the main factors in determination of the reorder point and subsequently EOQ and safety stock causes poor delivery precision and information sharing between supplier, MM, and WM. VP's current projects in improving the suppliers' delivery precision are perceived to create the desired changes in this area.

Moreover, MM's system which is only based on the weekly plans creates fluctuations in the operation of the downstream departments as well as inefficiencies in the whole internal supply chain. One of the main reasons for using these weekly plans is the shortcomings in VP's planning system and its inability to handle the daily delivery schedules. The other reason relates to the advantages it creates for VP to save costs by using milk runs. However, using weekly delivery schedules grants unnecessary delivery flexibility to the suppliers. This creates a lot of waste and therefore a need for excess inventory in the system to ensure the availability at the customers. This fact also implies lack of consideration in MM on availability at the right place. The reason is the problems it creates for the other departments in optimizing their work. In this respect the major performance indicator of the MM, i.e. turnover rate which is measured on an aggregated level, cannot have the necessary control on the right location of availability. This is true since measuring the performance on an aggregated level, disregards the different characteristics of parts and consider them as the same.

Warehouse Management

In the warehouse operation the major goal is to deliver the parts just in time as they are needed downstream in the distribution network in order to guarantee the availability of the parts. However, similar to the MM department, there are some barriers in the way of fulfilling the defined value. These obstacles appear in the process as work-load variation which is in turn a result of the procedures set internally in the WM department as well as the policies in other linked departments such as MM department.

Decisions taken in MM affect how WM is setting up its work. Setting weekly schedules in MM, for example, results in variations in the goods arrival at the warehouse and creates problems in resource allocation which will later show up as unavailability of the parts. In addition, VP's strategies towards buy-backs in terms of flexibilities for the dealers to return the parts to the warehouse make problems in allocation of resources. Since the warehouse management does not have any control over the arrival of buy-backs to the warehouse, planning for resource allocation would be difficult. Improving the buy-back flow will undoubtedly assist the warehouse in this respect. This can happen by providing the warehouse with the exact information on the amount of parts and their time of arrival. As a known fact, in a long-run perspective creating accurate forecasts and adjusting the stock order deliveries will reduce the amount of parts coming back to the distribution system and resolve part of the warehouse's problems. The same applies when it comes to the refill returns from the support warehouse. Deploying more accurate forecasting strategies and using them as the basis for stock holding policies have fundamental effects on improving these flows in the system. MM can also influence on the receiving lead time at the warehouse by motivating the suppliers in ensuring the quality, before parts are sent to the warehouses. This will later decrease the waiting time (and consequently the lead time) and hence have a direct impact on the parts availability in the warehouse.

Apart from MM's policies creating disruptions in serving the value, some other problems can be tracked in both MM and WM. Back-orders which is normally a critical problem for the supply chains, originate in VP partly based on MM's failure in serving the availability and partly due to WM failure in monitoring the right metrics. Improving the forecasts by including the knowledge and experience of material planners in a standardized way into the forecasting decisions will decrease the errors and supports the reduction of the back-orders, returns and prioritized flow in the warehouse. Additionally, the role of WM in reduction of the back-orders is to reduce the possibilities of the nil picks occurrence in the system. At the current situation the eceiving team is only scanning the parts in the receiving process and not binning. Scanning the parts and its location in the binning process will increase the accuracy in the process and reduce the nil pick error. However, the costs and time spent for this additional activity should be further investigated.

The role of WM in securing the availability is not restricted to back orders. Organizing the processes in the warehouse create prerequisites with which the WM can improve the availability. Creating coordination between the different teams in the warehouse is one of the

most important factors in this respect. In addition, the structure of the activities such as picking, sorting and packing influences the efficiency of the process. As an example, the sorting process which is currently done after the picking creates waiting and errors in the operation. This together with all the pinpoints mentioned in this section will further result in increased and instable lead time which in turn will affect MM's decisions or procurement and refill. The direct effect of all these consequential activities and decisions will appear as problems in handling availability at the customers and will create huge costs in the system.

Order and Distribution Management

ODM department is positioned at the end of the supply chain and defines its value as the availability of the parts at the customers. In this respect, the department has simplified the dealers' process of ordering and receiving by developing automatic systems which gives the dealers the possibility to place the orders in the systems as soon as the demand arises. At the same time, it has set up systems such as VV and POL to create a smooth information flow between VP and the dealers. These systems as a means of information sharing provide transparency between the dealers and the company and support the dealers in providing better availability and services to the end-customers. The close relationship the department builds with the dealers enables both the company and the dealers to be able to meet the demand straightforwardly.

VP policies in dealer management have also set the VMI structure at the dealers which creates opportunities to reduce the waste, errors and information flow difficulties from the supply chain. The other policy of ODM department in this respect, LPA, helps the dealers to improve the availability by taking advantage of VP's buy-back and return policies. However, in this later aspect, ODM department should ensure that the policies are accurate and do not impose unnecessary costs to the company. Otherwise, the effects of such policies not only create costs for the system, but also will influence the availability negatively by causing disruptions in the other actors' operation in the supply chain.

In the area of physical distribution, the department serves its value by creating an efficient system, for the stock orders, through consolidated transports with milk runs to the dealers on a daily basis. In addition, policies such as providing the stock orders directly from the central warehouse in order to minimize the number of movements and day orders from the support warehouse to create shorter lead time helps the dealers to benefit from better availability through an efficient logistical solution.

Supply chain

Having an overall look upon the actors in VP internal supply chain highlights several facts about the perception of value, in the system. Generally speaking, the defined value in the whole system is identified and emphasized as the availability for the end-customers. However, taking a closer look to the activities, processes and policies reveals the barriers and problems which create contradictions with the value. Although at the first sight the value appears to be

availability at the end-customers, but the metrics and configuration of the processes gives a confusing view of it. The structure of the supply chain which is on a functionality basis with separate isolated departments creates the environment for focusing on sub-optimizations in each department. Therefore the actors within the departments normally fail to see and consider the end-customers' perspective on value. In addition, since the processes are dependent and have corresponding effects on each other, even sub-optimizations in the department and focusing on the value will be difficult to achieve. As a result of the functional design of the processes and the local focus in the system, the departments have little considerations about the operation in the up/downstream sections and create unintentional disturbance for the other functions and their attempt to meet the value. This will further create turbulence in the system, impose unnecessary costs to the company and leads to difficulties in serving the customers.

5.2.2 Value Stream

As mentioned in the previous part (Section 3.2.2) of this report, investigating the value stream in the companies should be the next step after examining the company's value and aligning it with the end-customers'. In this respect, the need for VP to align its values practically (through aligning the processes and activities) is a prerequisite for studying the value stream. Nevertheless, for the purpose of this report and in order to evaluate the lean principles in VP operation, this section is devoted to underlining the major waste sources in the process and distinguishing them from the other activities. For this reason and in order to not distract from the main aim, this section will not cover the value stream mapping for the processes at VP. However, the importance of value stream mapping through the tools introduced in section 3.2.2 is once more emphasized and recommended for further investigations and projects in the company.

Material Management

As mentioned earlier, waste in the activities includes the things customers are not willing to pay for. This will both cause problems to meet the customers' values and impose costs to the companies. In this respect, all the activities done in the MM (and later in WM and ODM) should be reviewed from the customer-centric perspective and the non-value-added activities should be eliminated without any bias. Since the activities done in the MM department are more of tactical decisions which have a direct impact on the decisions made downstream, they can cause huge sources of waste in the organization. Therefore, taking a critical look at all the decisions made in this department is of high importance.

Looking through the barriers and difficulties which keep the MM department from focusing on the values highlights the waste happening in the process. MM's forecasting method which causes major turbulence in its upstream (suppliers) and downstream (WM, ODM) is one of the main areas requiring improvement. The problems created by forecasting method ranges from excess inventory in the system to time-to-time stock-outs. This, which further causes work-load variation in the WM department as well as ODM department, results in waiting and

long lead time in the system. Long lead times affect the company's policies regarding replenishments and re-order points. In addition, the delivery schedules which are set on a weekly basis interferes VP ability in planning the later activities and its optimizations for resource utilization. Hence, it creates waste in the organization in terms of waiting and extra costs as a result of work load fluctuation.

Warehouse Management

The waste in the WM is partly the result of inefficiencies in the warehouse operation and partly because of decisions made in MM. While the WM should heavily focus on the sources of waste created in the warehouse, it should also try to level the delivery fluctuations caused by the MM department through optimization of resources.

Errors occurred in the warehouse such as receiving and picking mistakes, falls directly into one of the eight sources of Ohno's waste, defects (Womack and Jones 2003). This engages 15% of the receiving team's time each day which is a considerable amount. Hence, warehouse should put its most effort on reducing and eventually eliminating them. Employing tools and methods to improve visibility (which is already mentioned in the theory as the six methods introduced by Baudin (2004)) and training are some of the solutions for such problems. Additionally, quality inspections in central warehouse, is an obvious evident of over-processing and can be eliminated by motivating the suppliers for running quality assurance programs. All these types of waste cause waiting and stoppage in the operation.

Furthermore, the procedures in the warehouse regarding receiving and picking operations need to be revised and the waste in the operation should be eliminated. Two major areas, in this respect, are coordination between the teams in the warehouse and the operation structure. Currently, the interfaces between the teams in the warehouse create considerable waiting time and stoppage. At the same time, the operation structure has led to major unnecessary motions. For instance, the sorting operation which is done after the picking is done increases the number of times the parts are touched. This will also increase the probability of the errors.

Order and Distribution Management

Recognizing the value stream and talking about waste in ODM is harder than the other two departments since most of the operations in this department is performed automatically. In fact, ODM department has contributed to the end-customers' value to a great extent by developing the systems. Through these systems the end-customers' demand is communicated with VP in a short time span which results in a smooth information flow to the system and builds close relationship with the dealers as the interfaces with the final customers. At the same time, the distribution of parts to the dealers is done in an efficient way through milk runs which eliminate the waiting in the system. Direct deliveries from the central warehouses and the use of consolidation to cut the costs and work more efficiently, are also supporting the fulfilment of the value. On the other hand, introducing the LP agreement and the flexible policies about the buy-back flow has facilitated the assurance of availability in the system.

However, since this later creates a lot of extra work for the WM and at the same time is the result of the forecasting errors, it is considered as the second group of activities, i.e. necessary but non-value-adding.

Supply Chain

Investigating the value stream should be done in all activities within the company regardless of the departments' boundaries. In fact, a lot of waste is created in the interfaces between the functional departments which are a result of lack of coordination. Since the departments in VP do not look at the value as one value for the whole supply chain and try to sub-optimize their own decisions or operations, they create disruptions for the other actors in the supply chain. The workload variation in the warehouse or the delivery issues in the ODM department are examples of such waste. If VP departments continue on sub-optimization and do not capture the overall view on the value, building a value stream where all the non-value-added activities are eliminated from the process would be unachievable.

5.2.3 Flow

As mentioned in theory by Womack & Jones (2003), flow principle focuses fundamentally upon the transformation and movement throughout the chain from production and distribution to consumption. The actors and departments in VP have a problem-oriented focus today aiming at fulfilling the goals set up.

Material Management

One of the two main objectives and goals in the MM department is providing availability in the distribution network. The organization is from a point of view divided into two units accountable for availability at the dealerships and the distribution network facing the dealers. Womack & Jones (2003) argue that avoiding stops and barriers in the value stream is an approach which facilitate flow and minimize lead time for information and physical flow to reach its predetermined direction. MM structure supports these ideas by creating a standardized way of both push and pulls the parts from the internal distribution network out to the dealers. They use a rule-based logic which determines and serves the allocation of parts. The problem in the system is the ordering process which is more based upon batch thinking and thereby causes a delay in information sharing upstream. Disparate communication and coordination causes delays and problems in providing updated information upon which downstream processes can base their activities. This is what Jones et al. (1999) defines as a functional-oriented organization focusing on costs.

Policies and procedures in the MM for stock keeping decisions are as previously mentioned based upon rules logic. The proliferation of spare parts is affecting the network nodes, central and support warehouses, especially in the slow moving part range. In this respect, market characteristics should influence a new mindset when it comes to develop new best practices and tools to adapt to new flows in the distribution (Womack and Jones 2003). VP is further developing their LPA solution which increases the instant availability at the dealerships to

improve the distribution of high frequent parts through stock orders. The increase of low frequent parts in the last decades argue for using new strategies and tactics to minimize the stoppages and scrap by using a differentiation between the low frequent and high frequent parts.

Suppliers upstream in the supply chain are providing parts directly to the central warehouse. The ordering process from the MM side bases their decisions upon current inventory levels at the warehouse and the forecasting. The delivery schedules are created and communicated to the suppliers. There are time fences and stability rules for volume and mix which is in line with Womack and Jones (2003) argumentation of eliminating the stoppages in the flow. This creates levelling to increase utilization of resources by being able to optimize the planning and allocation of them. The current structure and supply chain is handling forecast aggregation but lack the coordination of delivery plans which means that there is no synchronization of plans between the support warehouses and the central warehouse.

Warehouse Management

The warehousing operation is the focal point of spare parts distribution where the main activities in the distribution network are executed. In the central and support warehouses the main categories of activities are divided into inbound flow representing receiving and storage and outbound flow which is responsible for the picking and shipping operations. The flow of parts are based upon these activities and the inventory is the decoupling point were the levelled manufacturing meets the more fluctuating demand of distribution. Taken the inventory as the point of the departure its presence is justified to serve the customers unpredictable needs and expectation which is a central approach in the lean principles and is also supported by Womack & Jones (2003). From there the warehouse organization especially in the receiving operations could benefit from increasing the visibility. One solution could be to improve the parts presentation by using compartments in the pallets. This will increase the visibility in the parts presentation to support the quality processes and minimize the stoppages and lead time. Davies (2007) argues that error and time spent upon identification and control is reduced by using visualization in presentation.

Focus at the warehouse processes is to minimize the number of activities and consequently decrease the handling of parts. The importance is to understand the cost drivers. Balancing the cost and performance for customer satisfaction is a trade-off based upon deep knowledge and understanding in the value creating flow. Van den Berg & Zjim (1999) point out the picking process account in the interval of 50-70% of total costs originated in a warehouse operation. VP organization have taken initiatives and strategies in this field and introduced fast lanes known as golden zone, characterizing parts with high picking frequency to minimize the stoppages and improve flow in the warehouse.

Delivery of parts from the suppliers into the VP distribution network is controlled and decided by the delivery schedules which determine the plan for the demand of the forthcoming 52 weeks. In the current setup the ordering process and plans are based upon a weekly basis. This

creates difficulties for resource allocation and also the coordination and interaction of activities between the suppliers, transporters and the receiving operation at the central warehouse in Gent. Facilitating cooperation outside the traditional boundaries and responsibilities is a main element to achieve flow between the three actors; supplier, MM, and warehouse operations. In this situation the organization must define the needs and expectations demanded towards the supplier determining the link of activities and ties of resources.

The market characteristics create uncertainty of the upcoming demand at the dealers based upon a first prognosis of the problem. The distribution setup provide therefore solutions which make it possible for dealers to have availability directly to minimize the lead time and increase the prerequisites for uptime for the end-customer. Providing these solutions the distribution acts proactively and creates value for the customer. This causes reverse flows of parts back into the distribution network with administration and return logistic setups.

Order and Distribution Management

Distributing parts from the central and support warehouse out to the dealerships are based upon the order fulfilment strategy and the market characteristics. The relationship and governance structure between the business areas and VP is characterized by a high presence in controlling and owning strategic dealerships around in the European market. Therefore, it is important to adapt an ordering process in communication with both the business areas and the dealers which is minimizing the effort and hassle in the operational level. This is also in line with lean consumption theory. Flows play an important role in developing a well functioning ordering process. Baudin (2004) have identified three flows which is supporting the lean principles and the fulfilment strategy; material, information, and financial flows.

LPA's central position in the VP distribution network is one determinant affecting the material flows. Using strict rule-based principles of replenishment with reorder points and economic order quantities controls the parts movement from the suppliers into the central warehouse which replenish the dealer inventories. The general understanding in VP organization is to use the main material flows for parts entering the distribution network. This means that parts enter only through the central warehouse and out to the dealers. In order to create all information needed in the distribution network the setup of activities is based upon that the parts are entering the distribution network at the central warehouse. Hence, Hines (2004) further argues for flows which adapt to the resources and activities to improve the material, information and financial flows. Argument for using only central warehouse for the incoming flow is consolidation in transport but also administrative tasks for legal and system specific information.

Moving from a functional-oriented approach, the distribution could exploit the possibilities to identify the appropriate position in the supply chain for a decoupling point. The network today is to provide stock orders from central warehouse to establish dealer inventories in a specific part range and day orders from support warehouses. Extending the part range and

finding solutions to improve customer satisfaction with a well functioning order fulfilment strategy like VP does is in line with what Zylstra (2006) and Fischer (1997) describe as creating a flow which take a customer and lead time focus.

Supply Chain

For companies and especially for VP's organization, flow principle could be used to develop their vast distribution network and eliminate the stoppages and barriers. Understanding the flow principle VP can improve the performance by using a shared system which facilitates adaptation between the actors, resources and activities. In the current situation VP has separate systems in their distribution network. The aftermarket characteristics analysed previously determine the vast distribution network as competitive factor but it also put pressure to standardize the communication out in the network. The high number of interconnection makes it difficult to have high involvement relationships to all actors in the network. A solution is to rely upon principles and guidelines more than strict rules and procedures which the flow principle supports. The establishment of global processes which are concurrently undertaken could be focused more upon the flow and interrelation between the different functions and departments within VP. To further emphasize such initiative the standardization of processes and activities are one important piece in the puzzle to engage employees with the best knowledge and define best practices within the organization.

5.2.4 Pull

In order to create a distribution network which allocates parts and resources efficiently it is important to understand the end-customers using the Volvo products. Pull is a principle which serves as a signal for establishing mechanisms and taking the point of departure in the occurrence of a need and the following steps to fulfil and satisfy this need.

Material Management

Practices in the material management use the sales statistics and demand from the dealers as input in the determination of the forecasts. As described earlier, the order fulfilment strategy which is used in the European setup for VP is to use only central warehouse as the point which receives the incoming flow. The replenishment cycle in the network is based upon forecasts and reorder points which make it a forecasted pull and do not have a direct link to the demand. The pull principle argued by Hopp and Spearman (2004) should be interpreted as manufacturing parts with a make-to-order philosophy. It is also said by Fischer (1997) and his P:D model that lead time and willingness to satisfaction determines the strategy of the distribution network. The VP organization uses their allocation of parts by automatic replenishments and refill inventories at the central warehouse, support warehouse and dealers. This could be seen as system and mechanisms which support locating the right parts at the right place. The difficulties are to further decrease the inventories to match the demand better on the supply side. One difficulty is the worldwide presence demanding short lead times due to condensed areas of supplier clusters.

Applying a vertical distribution network, the forecast could be aggregated and uses the law of big numbers to improve accuracy and performance in the MM. The problem is the lead time built in the system which is causing delays in information sharing and decouples the idea of pull running from the dealer upstream. MM's use of pull should facilitate flow of information and changes in the demand and consumption patterns.

Warehouse Management

In order to improve the order processing, lean principles and especially pull could be applied. The case description described the differences in the ordering process between the central warehouse and the support warehouse. The central warehouse outbound operations have several flows for all order classifications which make it easier to establish standardized work and a levelled scheduling. Hence, using practices to allocate resources and facilitate pull in material flows could connect the incoming orders with the activities in the pick, pack and shipping operations. In the support warehouse the prerequisites for levelling the workload is different because it only handles day orders. The solution used is to estimate the need for personnel in the outbound operations and when the order window is closed there is one more reallocation of resources if needed or replaced in housekeeping activities. These procedures are essential in using a pull strategy presented by Hopmann and Spearmann (2004) and using standardization and levelled workload to act proactively.

Order and Distribution Management

Dealers are ordering day orders and VOR orders manually based upon the upcoming or latent need from customers. This is pulling parts from the support warehouses and due to the characteristics of the spare distribution market it could be seen as a pull principle of providing a solution when it is needed. The stock orders are directly supplying the dealers from the central warehouses which means that it could seen of a more push strategy of placing parts at the dealers to achieve availability. Womack and Jones (2003) argues that an organization should pull when they can and push where they must and this comes back to the P:D model by Fischer (1997) which highlight the distribution velocity and cost trade-off as a factor that justifies inventories close to customers.

Reverse logistics covers the parts sent back to the facing warehouse due to discrepancies, buy-back or return. The flow in the reverse logistics is based upon the sales statistics and time windows for buy-back to create a levelled scheduling in the reverse operations at the warehouse. In the buy-back flow the time windows are due to the inactivity in the stocks at the dealer inventories. All these returns are a failure for the distribution network to satisfy the customer and due to discrepancies. The other reason for the returns is the opportunity costs in relation to increased sales and service which accepts a certain amount of return flow to raise the availability for the dealers and increase the uptime for the customers at the dealers.

Supply Chain

In the VP organization there are systems used to establish clear signal of what is needed and also when it is needed. The problem is that there is little consideration of presentation or how it should be done which could have great importance for the next actor in the chain. The lack of understanding of other processes in the internal supply chain creates waste which is due to poor communication and standardization of how things should be done. The understanding between the different departments and actors should be increased to make it easier to justify the use of takt-time. In VP's organization the cycle time at the warehouse is seen as the takt-time. Hence, communicating the organization's point of view is important to create this understanding and acceptance. This helps the processes to work in the same pace as the next person in the chain want it and strives for make-to-order by stepping away from a batch thinking mindset.

Perfection

Perfection in two words is radical change and continuous improvement. To eliminate all the waste from the organization, VP should not hesitate to eliminate any activity which is not creating value for the end-customers. This approach includes all the decisions and working procedures in the organization. However, taken from the theory (Womack and Jones 2003), the changes should be done according to a structured change plan set up by the top management. In this respect, prioritizing the changes in several phases and starting with the major ones is essential. In addition, setting accurate quantitative targets in order to be able to measure the performance is a key factor.

Material Management

At the current situation the main problems in the MM department influencing the flow of material and information can be divided into three areas: forecasting method solely based on the historical data, the batch order processing approach disrupting the information flow in the system and weekly delivery schedules. While forecasting based on the historical data and processing the orders in batches are a part of MM policies, the weekly delivery schedules is more a consequence of the limitations in the system and the cost-saving strategies. Hence, in order to make improvements in accordance to lean philosophy, the top management needs to start with initiating radical changes in the mentioned areas. To do so, first of all environment of trust should be established and the material managers should be given the opportunity to employ their knowledge and experience to make necessary changes in the forecasts to a limited extent and based on a specified rules and regulations. Secondly, the culture of "the bigger the batches, the better" should be corrected in the system and the importance of a smooth flow of material in the system should be highlighted in the organization. Lastly, the replenishment system towards the suppliers which is quite old should be improved giving the material managers the ability to create plans on a daily basis. The next step towards perfection is to seek for other opportunities of improvements in the department to increase availability.

Warehouse Management

The decisions made in the warehouse management department are on the operational level and hence the improvements developed in this department are of a different nature compared to other departments. Although the warehouse management department has already started improvements by implementing some changes such as establishing the reserve and forward area, but there are still major problems to be addressed. The main problems in the warehouse management are coordination between different teams, the structure of the activities and the quality issues. In order to attack such problems the warehouse should set up decisions to establish more communication between the different team managers in the warehouse. In addition, together with the team managers, the warehouse managers should come up with an agreed solution in order to optimize the working process in the warehouse on an overall level and to avoid the sub-optimizations. At the same time the structure of the activities should be continuously reviewed to ensure the deployment of the best practices all the time. In this respect, the employees should be considered as a valuable source of information, since they are the ones who are doing the activities and have the best knowledge of how the process work. The sorting activity is an example of the improvement requirement. Sorting in the warehouse which is done after the picking activity is completed, takes extra time and involves more handling which increases the possibility of errors.

The quality issues should also be addressed in the warehouse. This problem, which wastes a lot of resources (in terms of time and manpower) in the warehouse and imposes considerable costs to the organization, should be corrected before the parts are shipped to the dealers. To target this problem, training the workers and controlling the inbound quality through the right metrics is perceived to have a great effect.

Order and Distribution Management

ODM department should work with the perfection process through continuously improvement of the systems and physical distribution. The improvements in the systems include the interface systems between VP and dealers as well as the adapted VMI systems which deal with the ordering and receiving. Regarding the LP agreement between Volvo Parts and dealers, order and distribution department should review the rules and procedures continuously to ensure that while they are aligned with the end-customers' values they are not imposing unreasonable costs to the company.

Supply chain

Taking the overall view upon the whole internal supply chain, perfection is achieved through the changes in the organization of the department. One of the main building blocks of lean thinking is to orient the activities around the processes and not the functions. Hence in order to achieve to the perfect level of lean philosophy, VP needs to eliminate the boundaries of the functions and facilitate the communication between the activities performed in different departments.

The employees' perspective upon the problem solving is another issue to be considered. The fire-fighting attitude towards the problems, which is turning to the normal behaviour in the system, is leading to reactive responses to the problems instead of taking a proactive role. This behaviour is frequently defended as the best possible solution in reaction to the lack of time for root-cause analysis. To be able to reach the perfection level in the organization, VP needs to create the culture of change between the employees and motivate them for initiating future changes. This can be done through different training programs, but the most effective method for this purpose is to show the employees how the top management believes in and supports the positive changes in the organization. Trust and empowerment are two key terms in this respect.

6. Discussion

This project has evaluated the VP's main actors and their activities from a lean perspective to investigate the potential improvement areas and the challenges the company faces in moving towards lean. However, due to the scope and delimitations of this report which necessitate a holistic view over the whole internal supply chain and prevent looking to the actors more in details, some interesting points have been left out. This chapter has covered the interesting areas worth to further investigate.

Aftermarket

Although fitting lean thinking in the aftermarket seems to bring undoubted success to the companies, a deeper consideration highlights many challenging areas. The ideal lean situation normally comes with the idea of creating a continuous one-piece flow of production which is created by the demand of the end-customer. This implies working in a stable environment with continuous stable demand from the customers. However, the best scenario for the aftermarket is a responsive organization to sporadic demands which makes the lean thinking utopia of one-piece-flow and level scheduling impossible. On a more detailed level, the best case scenario for lean with its one-piece-flow is to have zero inventories while this is not a case when working with aftermarket. Aftermarket which does not normally cover the production of the parts, needs the inventory (even in its best situation) to be able to act responsive to its customers.

However, stepping down from the ideal situation, what lean offers to the companies is a structured working process (in terms of operational activities as well as tactical and strategic decisions) which facilitates detecting the improvement areas and weak-points. The emphasis of the lean thinking on communication between the actors and visualization (so that everyone understands what is going on) suggest the ability to eliminate all the reworks, stoppages and waste in the company. At the same time, its focus upon eliminating waste and performing the exact things the final customers (who are going to pay for the service/product) wish, proposes the opportunities for decreasing the costs of the company and working more efficiently by exploiting the right amount of resources.

What is interesting in this context and has been also emphasized by the lean philosophy is the fact that there is no single way for the companies to follow lean. Companies need to do a thorough study on their market and the specific situations within their organizations and then customize the lean principles so that it fits their condition the best. Lean is unique for each and every company depending on its situation. Hence imitating what the other companies and in most of the cases competitors do will lead nowhere.

Warehouse

The foremost action the top management in organizations should carry out is to move the functional-oriented departments towards the process-oriented organization to enable the different departments in communicating and coordinating. However, apart from that, different departments still can perform activities in their own isolated areas to improve the process and eliminate waste. In situation where the departments to change the structure of the whole organization, blaming each other for the decisions taken without considering the other actors is not the best move. Instead the departments should make sure those problems do not keep their attention from focusing on their own operations.

In warehousing operation, as an example, there are fundamental steps to be taken towards lean. One of the main activities in this area is value stream mapping. The observations and interviews explicitly show the potential for improvements in the warehouse processes. Hence, value stream mapping will help to see how the waste is created in the warehouse and its effects on the lead time.

In addition, the problems in coordination and communication between the different teams in the warehouse are interesting to study. Since the teams are under the same department, it should be interesting to see what the barriers which create all the stoppages and waiting are in the warehouse. Nevertheless, due to the culture of the company which promotes functional-oriented thinking, it is not surprising to see these types of problems in the warehouse. The warehouse managers should communicate and discuss the problems in the interfaces between the teams and come up with solutions. This can even, create a starting point as a best practice for the other departments to follow.

Training and empowering the workers is one of the main points lean thinking emphasize on. Currently, warehouse management department has certain training programs for the workers to teach them the best-practice working methods. However, the warehouse should take a step further and establish procedures which aim at empowering the employees. This is a crucial task, since the employees are the best sources of knowledge when it comes to improving the activities. The reason simply is the fact that they are working with the structures and processes and hence, they can come up with the best solutions for improvements. Creating a culture in the warehouse where the workers know themselves as a part of the process and motivate them to think about the improvements is the easiest and least costly method to improve the activities.

Distribution

The market in Europe and international region are witnessing increased activity from organization within the automotive industry which has the focus of offering customers high availability of service. This has increased the reverse flows into the distribution network and created incentives to develop a differentiated service to the customers which correlates to their needs and expectations. The potential to improve and develop reverse flows are large by

enabling a more standardized approach in which the organization increasingly uses current flow and coordinates the exchange of information.

Although the reverse flows back into the distribution network of VP stands for a part of the total flow, but in comparison the level of the costs in the reverse flow is higher. VP should develop its return policies in a way that it supports the customers' satisfaction and at the same time does not grant unnecessary return opportunity. In the current structure, the system creates high costs in transportation and storage as well as a lot of management and control activities to handle the reverse flow. This creates incentives to reduce reverse flow and as a result of the high costs associated with returns it creates possibilities of large gains even with low reductions. The reduction in the return flow is also in line with lean principles which see the returns as waste. It is important to communicate to the customer the value which lies in a return policy and justifies a higher price.

Buy-back that is treated in case description is the return flow handled by the LPA makes it possible to return parts that are not sold within a certain time period. For this category, therefore, the focus is on creating the conditions to reduce the volumes that are the subject of buy-back but also a discussion to extend the time in storage.

Creating a distribution network which serves its purpose the company must identify how the parts move in the network and work systematically to develop this structure. Utilizing the resources and knowledge within the organization should be used to develop and create flows that take all the nodes in the network as a possible point for the development of the distribution. One way might be to use the milk runs that already exist and create virtual networks of dealers. There are opportunities for this in areas where the density of dealers is high, by creating a common stock for these companies. The introduction of this system can therefore allow for increased availability, when the size increases by virtually merging multiple dealers' inventory to one. The solution involves a greater commitment from the dealers which is motivated by reduced inventory and increased part range as the benefits that this type of solution creates. Developing this system and thereby creating rules and conditions which maximize benefits and minimize the effort of the dealers is essential.

Creating the possibility for receiving the incoming flow from the suppliers through several points in addition to central warehouse will reduce the number of actors in different flows. The current structure at VP is only using the central warehouse where parts enter the Gent warehouse and from there all actors in the distribution network (regional, support warehouse and dealers) are fed by it. Parts coming to Gent and sending out from there to the support warehouses creates additional handling but can also be seen as a consolidation point of parts at the same node. There are also administrative and quality activities that occur in the central warehouse which does not happen at the other nodes in the network. A change in the distribution network can be to identify streams where you adopt a cross docking solution to deliver parts directly to support warehouse without binning the parts in the central warehouse but still use it as a consolidation point. From a lean perspective, there are arguments in favour

of creating more flows from suppliers with less handling of parts in the central warehouse and thus remove a part of the distribution. Therefore, it is necessary to analyze the streams where you can take advantage of reducing the nodes. However, then the consolidation of administrative tasks carried out in the central warehouse must be done in the support warehouse.

7. Conclusion and recommendations

The purpose of this thesis was to investigate the challenges and opportunities of using lean principles in VP spare part distribution. In this respect, three research questions were proposed and were used as guidance for conducting the thesis. In this chapter, the three research questions are addressed once again and the conclusions are drawn based on them. However, the structure of the chapter is not oriented around the questions. Instead, the conclusions are categorized into three sections, i.e. managerial, tactical and operational (Figure 13) and their connection to each of the questions are clarified.

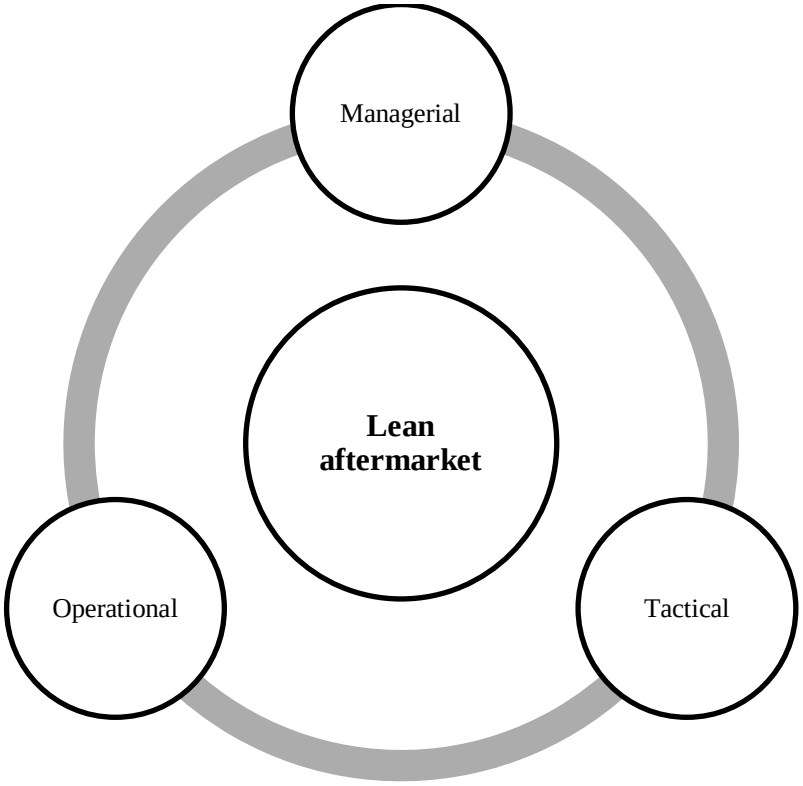

Figure 13 – Three categories of conclusion

Lean Aftermarket

The characteristics of aftermarket have been identified as providing availability for the customer to achieve customer satisfaction. Customers' willingness to wait for a product is shorter than the lead time for manufacturing which impose a need for inventory. In this situation the inventory is seen as value for the customer and therefore adequate. In a cradle to grave perspective lean emphasize a stable demand and decouple the erratic demand from the manufacturing and allocate inventory close to the customers to establish a stable demand in the supply chain. The reverse flow in aftermarket has a high return percentage which could be explained by the high potential profit of providing availability of parts to ensure customer satisfaction in comparison to the cost of providing this service and availability. This provides the answer for the first research question.

Managerial

Looking through the lean thinking lenses, the main conclusions on the managerial level address communication and problem-solving strategies. The current organizational structure at VP motivates the isolated functional-oriented departments working based on their own metrics. This is not, however, what lean thinking suggests. Lean philosophy bases its building-blocks on the ability of the organization to satisfy the end-customers. In VP's case, although the metrics are based upon creating availability in the system, less attention is spend to create availability at the right place, i.e. at the end-customers. Hence, each of the departments only considers creating the availability for their internal customers. Moving the departments towards a more process-oriented organization will remove the major barriers in sharing information in the company and facilitates the organization's focus on the availability at the right place.

The other critical factor to be addressed in the managerial level of the organization is the problem-solving issue. The lean thinking focus in this area is tackling the problems by investigating the root causes and providing the solutions for them. VP's attitude in this respect, however, is mainly towards the so-called fire-fighting mode meaning that the root cause analysis is seldom done while facing the problems. The lean proposal is to motivate the employees to look for the root causes when facing problems. This can be accomplished by empowering the employees to fix the problems from the source. Lean approaches in this respect include methods such as go and see for yourself and 5whys which emphasize on observing the problematic situation first-hand and asking about the causes of the problem many times until the root cause has been identified.

As inquired in the second research question, both communication and problem-solving strategies can be developed through applying lean thinking in the organization. This is also in line with the supply chain perspective in the analysis section. The summary of the managerial conclusions can be found in Figure 14.

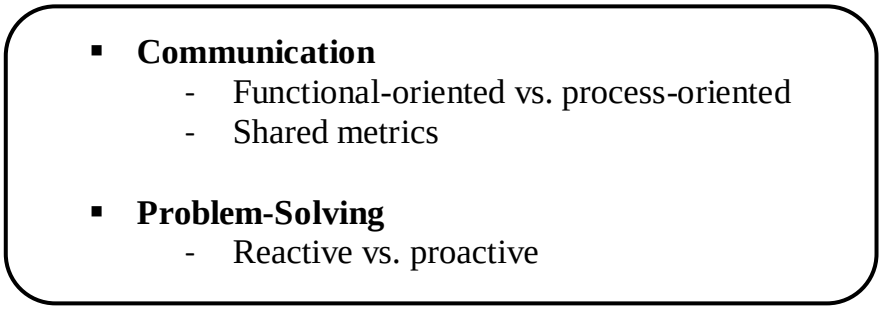

Figure 14 - Managerial conclusions

Tactical

In the investigation of the distribution network at VP, the interfaces linking the internal supply chain with the sourcing of parts from supplier and distributing parts to dealers have been identified to influence two areas; the order fulfilment strategy and the reverse flow.

Considering the reverse flow, VP has a liberal return policy by distributing parts which is returned to warehouses without creating any value for the customer. There must be a discussion of the trade-off between potential sales and cost of the return policy. Redefining the reverse flow is to decrease the resources and effort put in by the dealers and VP organization by focusing at value creation for end-customers. It shall also support increased share of the true customer-driven demand by developing incentives for such behaviour.

Regarding the order fulfilment strategy, VP's order classification takes little consideration of the differences in expectation and need between the different business segments. Hence, it should develop a distribution with a focus upon providing and matching the solution with the needs and expectations from the customers. In the current setup the parts are entering the VP distribution network through the central warehouse acting as a consolidation point. Investigating and developing the flows of parts to allocate the parts at the right place is to improve the flow and adapt to the behaviour of the customers.

Differentiating the distribution flows put strain on the interconnection and coordination between the processes. Supporting the differentiation of flows for the whole part range is to establish stability in the lead times between different operations. Therefore stabilizing the lead times is one factor which minimizes the fluctuations and creates possibilities to allocate resources. The ordering process should facilitate a smooth flow of parts. Therefore, improving the periods from weeks to days makes it easier to monitor and control the activities and achieve a better flow of parts and thereby exchange of information between actors.

For VP organization in which parts with low volumes and erratic demand contribute to the main share of the part range, forecasts play a central role in the operation. In this respect, VP should introduce an understanding of the methodologies and also develop a possibility to influence the forecasts in a standardized way with rule-based logic. This creates the opportunity in a structured way to utilize the information and knowledge of employees which cannot be extracted from historical statistics and obtained automatically. The summary of the tactical conclusions are presented in Figure 15.

- **Improving Reverse flow**
- **Order fulfillment strategy**
  - Differentiation of services
  - Stabilized lead time

Figure 15 - Tactical conclusions

Operational

On the operational level, the quality and standardization are the main findings. Quality which is mostly applicable in the operational level of the supply chain, i.e. warehouse management department, is related to preventing errors and facilitating the coordination between the teams. Lean recommendations for improving the quality are the extensive use of the visibility tools. Examples of these tools some of which has been already introduced in this report are zone identification, rack identification, slot separation, and rack orientation. Coordination between the different teams within the same department will also support the reduction of the stoppages and waste in the organization which is completely in-line with the lean perspective.

Standardization, as the second finding in this area, is mostly applicable in the warehouse management department but also is valid for the two other departments. Structuring the activities in the organization and ensuring the employees' commitment to it will both create the ground for improving the working process and also contribute to the quality improvement in the process. Training programs are one of the appropriate approaches towards the standardization.

The operational category of the conclusions together with the tactical category provides the answers for the third research question proposed at the beginning of the report. The thorough analysis related to the operational conclusions can be found in the warehouse management section in the analysis chapter. The operational conclusions are summarized in Figure 16.

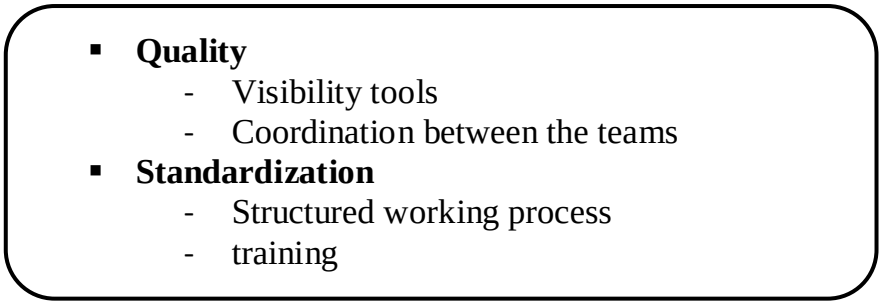

Figure 16 - Operational conclusions

7.1 Recommendations

- Develop metrics which support the goal in the company's vision and mission throughout the organization and make them aligned with this goal.
- Strive for tearing down barriers between departments and develop more of process-oriented thinking.
- Stabilize the lead times to facilitate standardization of activities and move away from reactive mode to proactive mode.
- Communicate the necessity of inventory to satisfy customers as supported by the lean principles.
- Establish incentives at VP to support having parts where they are needed.

7.2 Future Research

The main focus of this report was the investigation of the potential improvement areas from a lean perspective in VP's internal supply chain. Nevertheless, the broad scope of the thesis and its short time span was the reason why some interesting areas were left out. This section tries to highlight the future research areas which can be the focus of further investigations:

From a supply chain perspective, this report has only considered the three main departments, namely, MM, WM and ODM. Hence, it would be interesting to look further into other actors of the company. The role of the transportation in the distribution network and its interaction with the other actors is one of the interested areas to study.

Since the scope of this thesis has only covered the internal part of VP supply chain, it would be interesting to discover the external actors of the supply chain, i.e. the dealers and suppliers. As reflected in some of the interviews, the dealers' perspective and problems, for example, are likely to be different from VP's.

Given the fact that the emphasis in this study was mainly to cover and capture the holistic view of the whole supply chain it is interesting to go deeper into each department and investigate the detailed challenges and opportunities of each department in lean transformation. Reverse flow is one of the interesting areas in this respect to be investigated further.

As this report was only devoted to the investigation of the challenges and opportunities, it would be interesting to see how the improvement proposed in this report can be implemented and how the implementation results support the results of this project.

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9. Appendix I

Conducted Interviews			
Name	**Unit**	**Position**	**Date**
Alf Lennerstad	Material Management	Business Application Analyst	2011-03-23
Magnus Bernson	Material Management	Project Leader	2011-03-29
Christian Claesson	Order and Distribution Management	Process manager, Dealer inventory management	2011-04-05
Gert Svensson	Material Management	Business Application Analyst	2011-03-11
Ulf Höglund	Concept Development	Logistics Concept Development	2011-03-08
Pär Lidsten	Material Management	Business Analyst	2011-03-21
Mamun Abdullah	Warehouse Management	Process manager	2011-02-25 2011-04-07
Carina Frykstedt	Order and Distribution Management	Global Process Manager	2011-03-30
Bertil Prissberg	Concept Development	Manager Logistics Development EU	2011-04-04
Hannah Axelsson	Material Management	Material Manager & SRM	2011-04-08
Fredrik Svartborn	Material Management	Project Manager	2011-04-12
Alexander Hoogewijs	Warehouse Management	Team Leader, Central Warehouse Gent	2011-04-13
Johan Mellström	Warehouse Management	General Manager, Arendal Support Warehouse	2011-04-18
Patrik Isaksson	Quality & Customer Satisfaction	Vice President Quality & Customer Satisfaction	2011-05-04
Jonny Lundblad	Global Transport Management	Logistics	2011-05-06
Joakim Niklasson	Global Transport Management	Transport Manager	2011-05-13

Appendix II - Interview Guide

Questions asked from all interviewees about the lean principles and their position and organization.

Value

- What is your view upon lean principles?
- How is value defined by Volvo Parts?
- How would you define value?
- What activities is used to acquire the needs and expectation from the customer but foremost how is this information transferred to the entire organization?
- What is the strategy of Volvo Parts to create offers and solutions adapted to customer need and expectations?
- What do you think are the value-added activities in the supply chain

Value stream

- What is the level of transparency in the value stream to share information and knowledge?
- What is impeding the sharing of knowledge and information and how could Volvo Parts improve it?
- How is Volvo Part utilizing the knowledge between departments?

Flow

- How would you characterize the physical and information flow in Volvo Parts internal supply chain?
- How do you think more aligned metrics could help improving the overall performance within Volvo Parts?

Pull

- Is Volvo Parts using the pull principle to let the demand signal flow through the supply chain?
- What improvement could be made to minimize the distortion of the demand signal?

Perfection

- How could Volvo Parts work with their processes to further utilize and improve human productivity?
- How could Volvo Parts work with becoming more proactive and step away from fire-fighting mode (incentives, tools, coaching, structure)?