CHALMERS
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Setting Aftermarket Logistics Requirements in New Product Development Phase

Case study in Volvo Group

Master's thesis in Supply Chain Management

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021
www.chalmers.se
Report No. E2021:087

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SUMMARY

The aftermarket could enjoy a bigger market share often up to five times the size of new products. Aftermarket services also play a major role in customer satisfaction and retention. Due to this, companies can no longer treat aftermarket as a mere afterthought and need to strategically focus on it. An efficient logistics of the aftermarket would then enable firms to provide excellent services and maintain customer satisfaction. The aftermarket service has a crucial role in increasing the success rate of new products, so they believe that it needs to be evaluated starting as early as in the New Product Development (NPD) process. 70-80% of the cost of the product and environmental impacts are determined and locked at the design phase. Errors noticed in the early design phase can be corrected with ease, but errors detected later in the process result in expensive adjustments. Therefore, early involvement of logistics in the design phase not only could save cost and lead time, but also increase efficiency and effectiveness of the logistics functions.

Volvo Group understand that the importance of the business does not end after delivering the vehicles to the customers, but also how to ensure the vehicles continue operating safely on the road through its excellent, quick, first-class technical solutions. There has been an increasing awareness in Volvo Group to improve their aftermarket logistics operation and intend to adopt requirements of their aftermarket logistics starting from the early product development phases. They have identified the need to include functions of commercial packaging, transport packaging, dangerous goods, warehousing, and customs and trade. These functions form the core of Service Market Logistics (SML) department which handles aftermarket logistics in Volvo Group.

The purpose of this Thesis is to exhibit the importance of aftermarket logistics involvement in the new product development (NPD) phase. A total of 31 interviews were conducted within the above mentioned SML functions. The results of the Thesis project is a summary of NPD phases in Volvo Group and a list of 25 requirements explained in matrix to answer the research questions related to the identification of requirements from SML department, alignment with NPD phases, and consequences of SML late involvement in product development activities.

Keywords: New Product Development, aftermarket, inventory management, transport, packaging, dangerous goods, customs clearance, and logistics interface with product development

Acknowledgement

We would like to thank *Chalmers University of Technology* and *Volvo Group* for the opportunity to conduct this study. The study would not have been possible without all the guidance we received during the last five months.

Firstly, we would like to thank our supervisors at Volvo Group, Frida Berg, Veronica Andersson and Fanny Lefebvre, who helped us without a moment's hesitation. It was a pleasure working together with you and the Service Market Logistics department at Volvo Group. We are certain that the study would not have this result without all the encouragement and feedback from all involved.

We would also like to thank our supervisor and examiner, Gunnar Stefansson, at Chalmers University who has provided us with great inputs during the whole thesis. Your guidance and support helped us complete the study on time.

Dion Chacko and Julie Riyanti Teresa,

Gothenburg, June 2021

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1. Introduction

This chapter discusses the background, purpose of the research followed by the research questions that will be answered through the research. The authors have also included the delimitations and the structure of the thesis in this chapter.

1.1. Background

Customer satisfaction is a determining factor for any company's success. Though a product brings the customer to a company, the aftermarket services ensure customer loyalty. Some Wall Street experts also noticed that there are direct links between a firm's stocks and the quality of its aftermarket services (Cohen, Agrawal, and Agrawal, 2006). It is then critical for firms to realize that customers do not anticipate their products to be impeccable. However, they do anticipate firms to provide repairs for products that break down (Cohen et al., 2006). This has encouraged firms in recent decades to focus beyond the new product sales, into the aftermarket segment. This is especially true for the automotive industry where the sales of service market products such as spare parts are highly relevant and profitable to their business model (Wise and Baumgartner, 1999).

The aftermarket is a larger market than the new product market. The aftermarket enjoys a market share often up to four or five times the size of new products (Bundschuh and Dezvane, 2003). Alexander, Dayal, Dempsey, and Vander Ark (2002) point out that returning customers are highly profitable without efforts for marketing and relationship building, hence, aftermarket services play a major role in customer satisfaction and retention. Due to this, companies can no longer treat aftermarket as a mere afterthought and need to strategically focus on aftermarket (Cohen et al., 2006).

Globalization has increased the number of competitors for each product; performance, price and quality puts most of the competitors at par. Aftermarket can provide the advantage that helps firms to win against their competitors (Cohen et al., 2006). One example is Saturn which was the forerunner of using the aftermarket service as a strategic advantage for customer loyalty by creating an integrated supply chain network (Cohen, Cull, Lee, and Willen, 2000).

Customer demands also have been constantly increasing throughout the years and aftermarket services need to be available immediately at the best prices to satisfy the customers (Andersson, 2007). Aftermarket service satisfaction can be achieved with proactive planning along the supply chain. Ensuring spare part availability, process efficiency, optimal stock levels without drowning a firm and compromising customer satisfaction is crucial (Humphreys, 2011). To achieve this, companies have adopted supply chain management and logistics strategically in their operations (Storhagen, 2003).

Logistics efficiency is considered as an enabler of flexibility and integration of processes along the supply chains (Storhagen, 2003). An efficient logistics of the aftermarket would then enable firms to provide excellent services and maintain customer satisfaction and loyalty as proven by Saturn (Cohen et al., 2000). Goffin and New (2001) interestingly noticed that the aftermarket service has a crucial role in increasing the success rate of new products, so they believe that it needs to be evaluated starting as early as in the New Product Development (NPD) process.

Dieter and Schmid (2009) observed that 70-80% of the cost of the product and environmental impacts are determined and locked at the design phase. Additionally, it is also noticed that up to 60% of a product's lifetime cost is established at the concept design phase (Anderson, 2020). It is also noteworthy that errors noticed in the early design phase can be corrected with ease, but errors detected later in the process result in expensive adjustments. Therefore, early involvement of logistics requirements in the design phase not only could save cost and lead time, but also increase efficiency and effectiveness of the logistics functions (Andersson, 2007).

Wagner, Jönke and Eisingerich (2012) believe aftermarket logistics should contain "*market-orientated planning, design, realization, and control of the spare parts supply and distribution, along with associated information flows within a firm and between the firm and its network partners''.* In a typical firm this involves Packaging, Material Planning, Customs and Trade, Warehousing and Demand Planning functions. They help achieve a demand driven, optimal cost spare parts supply which are readily available and reliable (Wagner et al., 2012).

The Volvo Group is one of the world's largest manufacturers of heavy-duty trucks, construction equipment, buses, and heavy-duty diesel engines as well as a leading supplier of marine and industrial engines (Volvo Group, 2021). They understand that the importance of the business does not end after delivering the vehicles to the customers, but also how to ensure the vehicles continue operating safely on the road through its excellent, quick, first-class technical solutions. One way to realize it is through optimized aftermarket logistics. The aftermarket logistics team in Volvo Group Trucks Operations (GTO) operates under the name Service Market Logistics (SML). There has been an increasing awareness in Volvo Group to improve their aftermarket logistics operation. Volvo intends to adopt requirements of their aftermarket logistics starting from the early product development phases to ensure a reduction in cost, time, and waste which in turn increases customer value. They have identified the need to include functions of commercial packaging, transport packaging, dangerous goods, warehousing, and customs and trade as they are strategic to Volvo Group aftermarket logistics. These functions form the core of Service Market Logistics (SML) in Volvo Group and this study investigates these functions.

1.2. Purpose and Research Questions

The purpose of this Thesis is to exhibit the importance of aftermarket logistics involvement in the new product development (NPD) phase. The result of the Thesis would help the Service Market

Logistics (SML) department's activities in Volvo Group Trucks Operations (GTO) to transform from a reactive to proactive way of working.

Four research questions have been formulated and will be answered after conducting the research to fulfill the purpose of this Thesis project.

It is necessary to identify the phases and major milestones that currently exist in Volvo Group's NPD process. These phases will be the base reference when collecting the data of logistics requirements. This motivates the formulation of the first research question:

RQ1: *What are the major phases in the new product development (NPD) process in Volvo Group Trucks Operations (GTO)?*

From each function in the SML which include commercial packaging and transport packaging, customs and trades, dangerous goods, and warehouse, a set of requirements considered crucial to be fulfilled will be investigated. The requirements could emerge as their performance indicators or procedures before launching the products. Some requirements are dependent on the NPD process and the SML functions need to be informed or even actively involved in the process. However, neither the SML function nor the Product Development (PD) has the complete list of the requirements. Thus, it motivates the second research questions:

RQ2: *What are the important requirements from Service Market Logistics (SML) that need to be considered in the new product development (NPD) phase?*

After identifying the phases in the NPD and listing the requirements needed to be considered from an SML perspective, i.e., RQ1 and RQ2, the two aspects need to be aligned. It is important not only for PD to have the awareness to involve SML in certain NPD phases, but also for SML to weigh the level of involvement in each phase and plan their resources. This then leads to the third research question:

RQ3: *In which phases of new product development (NPD) should the identified requirements be aligned to?*

Other than conducting data collection regarding the requirements from SML, an analysis will also be done to investigate the current consequences faced by SML due to the lack of involvement in the NPD process. By doing so, a concrete reasoning to request for modification of the current running process can be presented. This leads to investigation of fourth research question:

RQ4: *What are the consequences of not involving Service Market Logistics (SML) in the new product development (NPD) phase?*

The scope of the project and relation between each research question is illustrated in Figure 1.

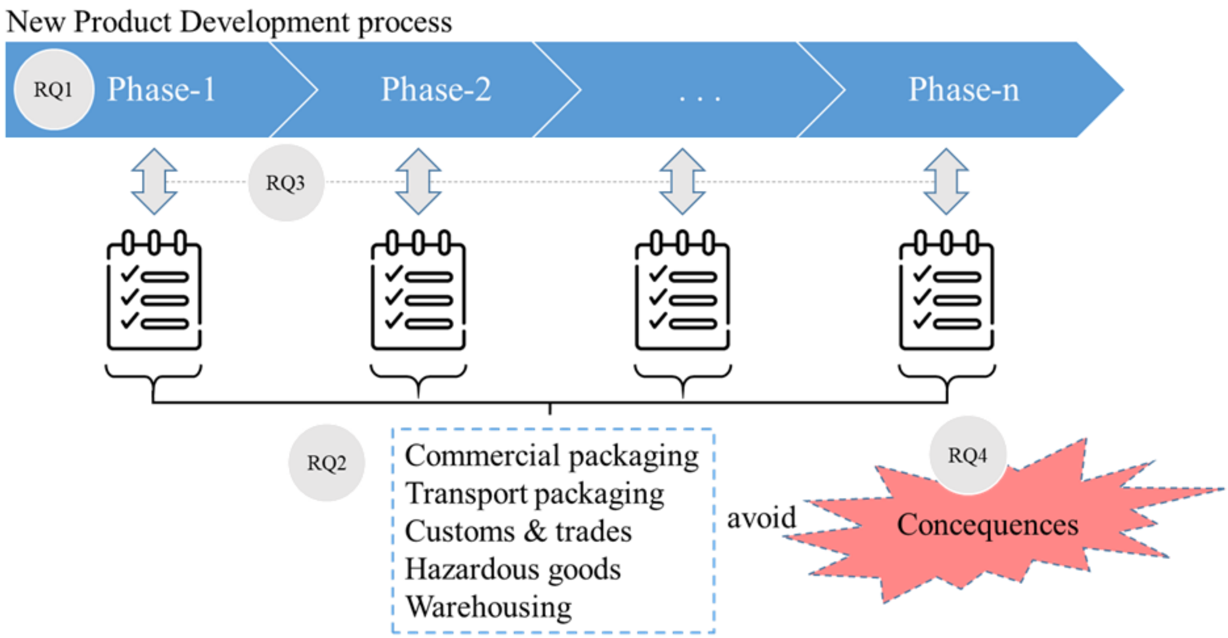

Figure 1 Master Thesis project scope

1.3. Delimitation

The Thesis project aims to achieve its purpose by giving recommendations for establishing a more efficient flow of both cost and time aspects in aftermarket logistics in Volvo Group Trucks Operations (GTO). However, the study will be focused on and limited to spare parts categorized as completely new parts and supersession parts. Completely new parts include parts never been used before or new technology while supersession parts are defined as parts replacing current available parts with similar function in the market.

The Thesis will focus on investigating related departments and organizations such as Product Development (PD) and Service Market Logistics (SML) teams located in Sweden and Ghent which cover operations in the EMEA region. It is based on consideration of similarity in culture and way of working, distance, time difference, and regulations that might affect the difference in the aftermarket logistics process. The Thesis will focus on the NPD phase with perspective from SML functions as input to improve it. The study will provide recommendations for new parts in the future market, thus the empirical result and comparison of the process before and after the implementation will not be covered in this Thesis project.

1.4. Thesis Structure

The Thesis report begins with an introduction chapter that presents the background of the research and brief discussion of aftermarket importance, followed by purpose of the study and research questions formulation and delimitation of the project scope. The second chapter elaborates the methodology chosen by the author in conducting the study, including research strategy, research design and method, data collection through interviews and company's internal documents, conducting literature study, as well as discussion about reliability and validity of the study. The literature review related to the study and knowledge needed to conduct the study is presented in chapter three. Findings of the study obtained from a series of interviews and Volvo Group's internal documents are presented in chapter four. Followed by an analysis to answer the research questions in chapter five. A discussion to compare the result with literature is presented in chapter six. Finally, conclusion and future research is presented in chapter seven.

2. Methodology

This chapter will cover the research strategy in conducting the Thesis study as well as research design and method to answer all the research questions. The authors have also included the validity and reliability of this thesis study.

2.1. Research Strategy

This thesis project will focus on how the Service Market Logistics (SML) department of Volvo Group Trucks Operations (GTO) can improve their way of working from reactive to proactive when strategically involved in new product development (NPD) phases. Bell, Bryman and Harley (2019) categorize three types of research strategy as quantitative research, qualitative research, and a mixture of the two. In order to answer the research questions and fulfill the aim of the project, a qualitative research approach is selected as the research strategy. Weathington, Cunningham, and Pittenger (2012) acknowledge qualitative research as an inductive process that develops a theory from the collected data. This would thereby help in overcoming the scarcity of research in the Thesis topic by collection and analysis of observations, experiences and narrative histories of the personnel working within the SML domain. The intended outcome of the research is the application of the results in most future projects involving new parts conducted by Volvo Group.

Regarding Bell et al. (2019) there are six main steps in conducting qualitative research, which consist of general research questions, selecting relevant site(s) and subjects, collection of relevant data, interpretation of data, conceptual and theoretical work which might be divided to tighter specification of research questions and collection of further data, and writing up findings/conclusions as the last step. In this Thesis project, the first and second steps are given in the initial topic from Volvo Group. The general objective is to answer, ‘How to improve the way of working from reactive to proactive by involving the SML department early in the NPD phase?’ and the relevant subject is the five functions within the SML GTO department. The third step of collecting relevant data is done by interviews and obtaining internal documents, which will be explained in more detail in chapter 2.2. The fourth step of data interpretation is done by analyzing recorded interviews and analyzing internal documents. The fifth step included literature review conducted before and during data collection, and finally the last step is completed by presenting the matrix and potential improvement.

2.2. Research Design and Method

Bell et al. (2019) in the book explain that the choice of research design will affect the way of data collection and data analysis, as well as prioritization of some dimensions in the research process. There are five research designs presented including experimental design, cross-sectional or social survey design, longitudinal design; case study design; and comparative design. This Thesis project is designed to implement case study research following the focus of the study on a single entity in a single organization which is to concentrate on the uniqueness of the organization and develop deep understanding of its complexity. Dubois and Gadde (2002) also argue that case study research provides strength because the interaction between a phenomenon and its context in a particular case could be studied in depth. As explained in the previous section, the study of this Thesis project is focused on a single entity within Volvo Group, namely SML department in Group Trucks Operations.

The research method is defined by Bell et al. (2019) as the technique for data collection. Data collection for this Master Thesis study is divided into two main steps. The first step is conducting preliminary interviews with Volvo employees considered related to the project. The details of the interview process will be explained in the next section. The findings gathered through the first-round interviews are documented and summarized in the SML requirement matrix. The second step of data collection is done by sending back the SML requirement matrix to each related person interviewed in the first round with the purpose to get feedback and fill in the missing information. Follow up interviews are done when considered needed from either or both the authors and the interviewees to discuss the final content of the matrix.

Analysis is also done based on all the data collected to align each requirement to certain NPD phases and identify the consequences and risks faced by SML when not involved early in the NPD process. In conclusion, the data collection would aim to identify the list of requirements demanded from SML perspective, timing of SML involvement in NPD phase, and the consequences of current lack of involvement in NPD phase. The data consist in the form of interview recording, any documentation provided by the interviewee in the form of a presentation file, excel file, and Power BI.

All the data gathered through interviews and documentation is utilized to give improvement suggestions in the form of matrix to Volvo GTO and SML department in specific. The analysis and suggestions are backed up by literature review done along the project.

2.2.1. Interview

The main method of data collection in this Thesis study is qualitative interview. It is argued by Bell et al. (2019) that interview is the most widely used method in qualitative research. Interviewing is seen as an attractive method due to its flexibility. The characteristics of qualitative interview mentioned by Bell et al. (2019) are less structured approach, more interest on the interviewee’s point of view, answers going off from main questions as well as follow-up questions are encouraged, and possibility of conducting multiple interviews with one person.

Semi-structured interviews were conducted with related functions within SML organization, due to unfamiliarity to the industry and the company. The interviews were done in order to narrow down the project scope, understand the general business process, followed by choosing the parts to focus on in the project. The interview questions ranged from general job roles of the interviewees, their involvement in the product development process, and the challenges they face related to late involvement in the NPD process. The interviews with SML employees not only have the purpose to map the general business process, but also to understand the way of working in each of the SML functions and discover the expectation of future ways of working regarding the SML involvement in the NPD phase. The interviews are categorized as initial preliminary research which are then complemented by initial data collection in the form of documentation of previous SML activities related to the NPD project.

After conducting interviews in internal SML organization and grasping a general knowledge regarding the business process and the gap that currently exists, a similar method of interview was also conducted with expertise in the Group Trucks Technology (GTT) department, Product Development (PD) team Spare Parts Engineer (SPE) team in specific. The purpose was to understand the high-level NPD phases and getting perspective from the (PD) side regarding SML involvement in the process. It is believed that conducting interviews is the most efficient way to grasp understanding of broad processes in relatively short time and obtain documents needed for analysis.

The semi-structured interviews allow the authors and interviewees to have discussion related to relevant questions. It also enables the authors to apply a snowball sampling method (Bell et al., 2019) where the interviewees refer to other person(s) seen to have more sufficient knowledge to answer some questions.

The interviews were conducted via an online meeting platform due to the pandemic situation. The first list of people to interview was provided by the authors' supervisor in Volvo Group. As mentioned before, a snowball sampling method allowed the authors to reach more people considered relevant for the interviews. A total number of 23 employees within SML functions and two employees from Group Trucks Technology have been interviewed during the first-round interview. The second-round interviews were conducted with 6 people to conclude the result from first round interviews. The full list of interviewees roles within the company can be found in the Appendix A.

2.2.2. Internal Document

Internal documents of the company were gathered through request to the interviewees and browsing the internal Volvo file sharing platform. The documents provided information related to each function studied in the Thesis project such as overview of the function, business process, and performance indicators. The documents also helped the authors to understand the functions better and acted as complement to the information gathered through the interviews.

2.3. Literature Review

In addition to data collection activity, a literature review was done before and after the interviews were conducted. The literature review conducted before data collection was to gain knowledge about the area of study and search for similar research, theory and concepts relevant to the study. However, the findings obtained from the first round of interviews signaled the necessity to conduct literature review in a broader scope.

The authors are applying the 'systematic combining' method presented by Dubois and Gadde (2002), where the theoretical framework leads to empirical data finding activities while the findings might result in unanticipated issues which need change or expanded theoretical review. During the thesis project, the authors needed to go back and forth between empirical findings and literature review due to the nature of the project which covers a broad scope and is considered as a new research area.

The literature study has been done by searching research articles through scientific databases such as Science Direct, Emerald, and Chalmers Online Library. As mentioned before, the project is considered to cover a broad scope and touch a relatively new area of research, thus a wide range of literature review combining different popular research areas was needed. Some keywords used include New Product Development, aftermarket, service market, inventory management, transport and packaging, dangerous goods, customs clearance, and logistics interface with product development. The authors also investigated reference lists of related articles to find research in related topics.

2.4. Ethics

The primary data collection of the Thesis work is through interviews with different people in the Volvo Group, hence it is imperative to conduct them ethically. Diener and Crandall (1978) breaks down ethics to four areas, which are, "*harm to participants, a lack of informed consent, an invasion of privacy, and deception*".

Harm to participants could be multiple facets including physical harm, any stress or attack on self-esteem, harm to career advancement or persuade the subject(s) to perform reprehensible deeds (Diener and Crandall, 1978). The interviews are conducted in the Volvo Group where the employees are treated with respect. The interviewee was informed that they were free to not answer questions they were uncomfortable with. Moreover, the interviews are confidential and the material that is used for the Thesis work is used with the interviewee's discretion. A lack of informed consent is not providing enough information to the participants to make informed decisions about their participation in the research (Bell, Bryman, and Harley 2018). All the interviewees were informed about the research topics and the intended use when contacted for the interview. Hence, all the information was provided prior to the interview and all the interviewees were able to make informed decisions about their participation.

Privacy of the interviewee should be respected by the researchers. Bell et al. (2018), explains the perception of intrusion is varied with different individuals and therefore it becomes essential to be careful while conducting research. Hence, a sensitive approach was adopted by the researchers to tailor questions to each participant and accept the feedback through the process. When the researcher is dishonest about the intentions of his research deception occurs and the participants would feel exploited (Bell et al., 2018). To avoid any exploitation of participant's goodwill all true intentions were declared prior to the interviews.

2.5. Reliability and Validity of the Study

The most distinguished criteria to evaluate the quality of a business and management research are reliability, replicability, and validity of the research (Bell et al., 2019). Each criterion related to this Thesis project will be discussed in detail as follows.

2.5.1. Reliability

The reliability criteria are concerned about the repeatability and replicability of the study, mainly in stability of the parameter used for measuring the data. Reliability aspect is usually more important in quantitative study compared to qualitative study. The reliability criteria consist of external reliability and internal reliability. External reliability discusses the degree of study replicability. In qualitative study, the replicability criteria are defined slightly differently since it is impossible to 'freeze' a social setting. Thus, it is suggested to adopt the similar social role of the previous studies. Meanwhile, in internal reliability the aspect concerned is the consensus among the members of the research team. (Bell et al., 2019)

The internal reliability criteria of this Thesis study was ensured by sending back the interpretation and summary of the recorded interviews to each of the interviewee to ensure that the authors understood and caught the message of the interviews. Any feedback from the interviewees is then added to the authors' document and sent back again to the interviewees. However, while the interview method of data collection gives high flexibility and is considered as one of qualitative study's strengths, it makes the external reliability of this Thesis study difficult to achieve, even though the same exact interview questions and settings are followed.

2.5.2. Validity

Validity criteria is measurement of the integrity of the conclusions in a study. It is argued that the validity criteria could only be limited to a certain extent in qualitative research due to no or less measurement being involved (Bell et al, 2019). Similar to the reliability aspect, validity also discusses internal validity and external validity. However, in contrast to reliability, internal validity is seen as a strength of qualitative research because of the intense participation in the social setting observation. External validity refers to the degree of generalization of the research across social settings.

In the initial phase of the Thesis study, the names in the interview list have been notified by the authors' supervisor in SML about the research overview prior to interviews, which was explained once more by the authors during the interviews to give more clearance. The feedback and cross-checking activities done by the authors to the interviewees are increasing the internal validity of the Thesis. In contrast, the external validity might be limited for this Thesis study. The social setting of this Thesis study could be generalized to certain extent and implemented to the other SML teams across Volvo Group around the world and other departments in Volvo Group with similar issues, and part of the Thesis study could be applied to other studies related to aftermarket involvement in the new product development phase.

3. Literature Review

The thesis study focusses on the aftermarket services and its involvement in new development processes. This chapter consists of the existing literature available on the new product development, aftermarket services, and the aftermarket involvement in NPD process.

3.1. New Product Development Process

New Product Development (NPD) has been consistently identified as the most uncertain but essential process in a firm (Schmidt, Sarangee and Montoya, 2009; Cooper, 1993). Though risky, when executed well, the process often results in a competitive advantage to the business. However, researchers over the years have noted the alarming rates of product failures associated with the NPD (Sivadas and Dwyer, 2000). The reduction in product life cycles have added pressure to the NPD process and the management is concerned with identifying the right process to secure a successful NPD process (Cooper, 1990). This led to a large number of investigations of the causes for the success and failure of a newly launched product (Calantone, Chan, and Cui, 2006).

Szwejczewski, Goffin, and Anagnostopoulos (2015), in their research concluded that success of a product depends on three key factors, namely a well-defined NPD process, presence of cross functional teams in various stages of NPD process, and right apprehension of customer needs. Meanwhile, Cooper (1990) identified the Stage-gate model as an effective tool to "*manage, direct and control*" the NPD efforts. A stage-gate model consists of a series of development stages where each stage ends with an evaluation gate (Hart, Hultnik, Tzokas and Commandeur, 2003). In his paper, Cooper (1990) compared the stage-gate model with a physical product during its manufacturing process. He explained that as a product proceeds from one workstation to the next after a quality inspection, the work done in each station is verified and approved at the gates.

The number of stages and gates are often determined by the company. The typical development stages according to Cooper (1990) is as shown in Figure 2.

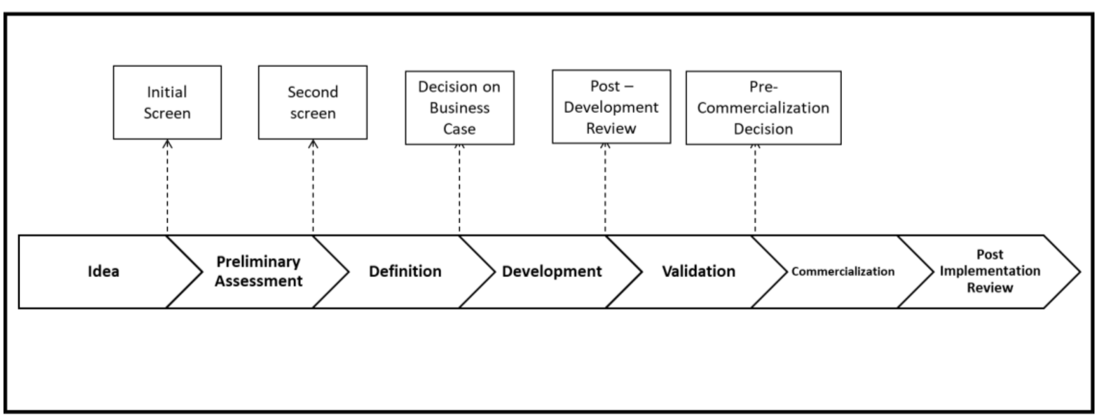

Figure 2 Product Development stages (adapted from Cooper, 1990)

Coopers' model forms as a base that can be customized for each firm's requirement. The stages and gates of the model can be described as follows (Cooper, 1990).

- **Stage 1**

Idea – The NPD processes is initiated with an idea which is evaluated at the Initial screening Gate

Gate 1 – Initial Screen evaluates the idea and the project sets in motion. It is a soft screen that subjects the idea to basic key criteria. It evaluates the criteria such as strategic alignment with the firm, the feasibility of the project, market perspective of the project. This helps focus the discussions of the project and rank them.

- **Stage 2**

Preliminary Assessment helps determine size of market, potential markets, and likely acceptance in markets. This stage could involve inhouse response to assess development and manufacturing possibilities, and costs and time to execute the project. This stage gathers information of both market and technical information.

Gate 2 – Second screening is a revaluation of the project with insights obtained from Stage 1. The passing of this stage moves to heavier investments on the project than stage 1. At this stage there are inputs from salesforce and customer reactions to the product. A quick look into the return on investments are also calculated at this gate.

- **Stage 3**

Definition The project should be clearly defined at this stage. An in-depth analysis of customer reactions is undertaken, and a competitive strategy is established. This stage also tries to include a possibility of concept testing. The technical viability of the project is analyzed, and the project is translated to solutions that are both economically and technically feasible. This stage can consist of preliminary designs. At this stage, it is necessary to investigate costs related to manufacturing and the necessary investments. This stage could also explore options of acquiring patents and copyright. A full-fledged financial analysis is also conducted.

Gate 3 – Decision on Business Case This is the last point where the project can be discontinued without huge losses. A pass from Gate 3 approves large investments. This gate verifies the financial analysis and the definitions of various items concerning the project. These items include target markets, product concept, product positioning strategy, desired product benefits, product attributes, features and specifications.

- **Stage 4**

Development stage As the name suggests this stage is concerned with product development, with testing, marketing plans and operations plans. Financial analysis is prepared and any issues such as legal, patent or copyright are solved.

Gate 4 – Post Development Review This gate reviews the product attractiveness and its progress. Development work is reviewed and checked for quality. This gate reviews the financial analysis on the most updated data. Plans made for the next stage are approved and elaborate marketing operations plans are further reviewed.

- **Stage 5**

Validation This stage checks for the practicality of the product, the production process, customer acceptance and the project cost. There a wide number of steps taken in the process such as:

1. Product performance and quality are checked in house.
2. Field trials are often conducted to understand the product's response in real scenarios and a customer's reaction to the product.
3. Pilot production is conducted to understand the production process and the costs associated with it.
4. Test markets to understand launch plans and to gauge the customers reaction to it.
5. Re-evaluation of financial analysis with updated data

Gate 5 – Pre-commercialization decision. This is the last stage to point where the project can be discontinued, post this the project is open to full commercialization. Financial analysis made in the Validation stage is determinant for this decision. The quality of activities of the validation stage is the primary focus of this gate. The operations plans for the implementation stage are approved at the gate.

- **Stage 6**

Commercialization This is the final stage in the NPD process where the focus is on the implementation of market launch plans and operations plans.

- **Stage 7**

Post Implementation Review Post commercialization in a brief time the product no longer remains as a new product and becomes just another product in the firm. At this point the process and product performance is assessed.

Ettlie (1997) noticed that an NPD process can be significantly improved by the involvement of all functions that affect the product life cycle, from the idea generation to its final disposal and Cooper's model enables those cross functional involvement. In practice, however, most companies limit the cross functional activities to marketing, manufacturing and R&D departments (Zacharia and Mentzer, 2007; Olson, Walker, and Ruekert, 1995).

3.2. Aftermarket Services

The aftermarket - also referred to as service market, after-sales service, customer support, product support - is a segment with a huge potential which has not been explored deeply by many companies. When any product is sold, along the life of the product it most likely will need aftermarket service - assistance to help the customers gain maximum value of the product they purchased (Goffin and New, 2001). The longer the life of the product, the bigger opportunities companies can offer on its aftermarket service. The aftermarket has a wide range of services that could include day-to-day inspections and maintenance, installing upgrades, reconditioning equipment, conducting repairs, and technical support (Goffin and New, 2001; Cohen et al., 2006).

In terms of size, the aftermarket is found to be four to five times larger than the new products market (Bundschuh and Dezvane, 2003). Cohen et al. (2006) mentioned that according to Aberdeen Group, the spare parts selling and after-sales service in the United States reached the value of USD 1 trillion every year which equals to 8% of its annual Gross Domestic Product. According to Grand View Research, in 2019 the automotive aftermarket itself has the value of USD 378.4 billion globally and is expected to grow rapidly at a compound annual growth rate (CAGR) of 4.0% between 2020 to 2027 (Grand View Research, n.d). Several other studies also reveal the higher profit margin gained from the aftermarket segment compared to other sources of revenue in companies.

According to Goffin and New (2001), a good aftermarket service is essential for manufacturers to achieve customer satisfaction and good long-term relationships, as well as creating companies' competitive advantage. Viewing from a company's cost perspective, it is also much cheaper to increase the sales in the aftermarket rather than finding new customers (Cohen et al., 2006). Aftermarket also plays an important role in reaching customer satisfaction. High customer loyalty rate is often obtained from customers' good experience of a firm's after-sales service (Cohen et al., 2006). A successful after-sales service also increases the chance of up-selling and cross-selling to current customers (Cohen et al., 2006; Szwejczewski et al., 2015). In the end, aftermarket becomes the longest-lasting and bigger source of revenues compared to the sales of a product itself while requiring the smallest investment (Knecht, Lezinski, and Weberet, 1993; Cohen et al., 2006).

However, many researchers found that most companies ignore or miss the potential that exists in the aftermarket (Cohen et al., 2006). One of the consequences of the ignorance to the aftermarket segment is for example, lack of coordination between the company's warehouse and its suppliers which causes delay in repair (Cohen et al., 2006). Cohen et al. (2006) also mentioned that in 1997, customer satisfaction levels in after-sales were between 10% to 15% below expectation and most probably has become lower nowadays since customer expectations have gone up throughout the years.

The reasons behind companies' ignorance of the aftermarket are because it is very difficult to manage (Cohen et al., 2006). The aftermarket network is more complex compared to manufacturing networks because it must support all the goods and spare parts the companies have sold in the past as well as in the present, which according to Cohen et al. (2006) is usually 20 times more SKUs (Stock Keeping Units) than the manufacturing. Not only that, but the demands in the aftermarket are also unexpected and sporadic, making the nature of the aftermarket unpredictable and inconsistent (Cohen et al., 2006). The profit of selling spare parts can be high but the inventory control is complex due to trade-off between parts availability and keeping slow moving parts (Goffin and New, 2001). Therefore, the supply chain for the aftermarket must be treated differently from the supply chain for manufacturing activities (Saccani, Johansson, and Perona, 2007). The differences of the two chains are shown in Table 1.

Table 1 Difference between manufacturing and aftermarket supply chain (adapted from Goffin and New, 2001)

Parameter	Manufacturing Supply Chain	Aftermarket Supply Chain
Nature of Demand	Predictable, can be forecasted	Always unpredictable, sporadic
Required response	Standard, can be scheduled	Fast response (same day or next day)
Number of SKUs	Limited	15 or 20 times more than manufacturing
Product portfolio	Homogeneous	Heterogeneous
Delivery network	Depends on nature of products; multiple networks necessary	Single network, capable of delivering different service product
Inventory management aim	Maximize velocity of resources	Pre-position resources
Reverse logistics	Does not handle	Handles repair, return, and disposal of failed components
Performance metric	Fill rate	Product availability (uptime)
Inventory turns (the more the better)	6 to 50 a year (low inventory)	1 to 4 a year (trade-off for parts availability for slow moving parts)
Profit margin	Low	High

The network of aftermarket supply chain consists of material which in aftermarket means the parts; people including engineers, call center staff, depot and warehouse staff, and transportation staff; and infrastructure for materials movement and storage, repair, transportation, information systems and communication (Cohen et al., 2006). In order to reap the benefits of the aftermarket, companies must provide their services in a very efficient manner (Cohen et al., 2006). It is argued that fast and efficient repair is crucial because in many markets the cost of down-time ranges from 100 to 10,000 times of the spare part itself (Goffin and New, 2001). One way to achieve that is to implement a strategically aligned and efficient aftermarket logistics (Wagner et al., 2012).

The functions considered to affect the success of aftermarket logistics related to this Thesis study will be discussed in detail in the next sections.

3.2.1. Packaging

Saghir (2002) defines Packaging as "*a coordinated system of preparing goods for safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal combined with maximizing consumer value, sales and hence profit.*"

Saghir (2004) in his paper remarks the effectiveness of a supply chain with respect to the packaging. He believes it represents the interface between a supply chain and the end user. The integration of packaging and logistics systems has the potential of an improved supply chain efficiency and effectiveness. Saghir (2004) also claims that currently there exists a need for identifying new concepts and solutions for packaging. For the development of these improved concepts of packaging it is necessary to consider packaging at the early product development stages. This would facilitate a smooth handling of the products along the supply chain.

Saghir's (2002) definition consists of fundamental function but besides this Jönson (2000) has summarized packaging under three categories as described in Table 2.

Table 2 Different packaging functions (adapted from Jönson, 2000)

Logistical Function	Facilitate distribution Protect both product and environment Provide information about conditions and locations
Marketing Function	Graphic design, format Legislative demands and marketing Customer requirements/consumer convenience for end use as well as distribution
Environmental Function	Recovery/Recycling Dematerialisation One-way vs reusable package Toxicity

The three identified functions of packaging by Jönson (2000) covers all essential parts of packaging but for the scope of this Thesis work we would like to limit our research to the Logistical function and to a small effect Marketing function of packaging.

Facilitating distribution is an important aspect of Logistical function of packaging. Well designed and effective packaging is essential to ensure that a product reaches its destination in the right condition (Rundh, 2005). In the 1990s there were huge demands on packaging, and this led to some environmental concerns. To counter this European Union (EU) introduced directives to minimize packaging waste. Hence, firms started adopting reusable and recyclable material for packaging. This puts a pressure on firms to evaluate their packaging options and have multiple options for packaging according to its specific use (Rundh, 2005).

Packaging logistics is a system that integrates the attributes of logistics, i.e., planning, implementing and control and the attributes of packaging i.e., containing, protecting, securing, promoting, selling, information and a source of profit. This integration leads to the establishment of a system that is efficient and effective (Saghir, 2004). This is summarized well in the definition of packaging logistics provided by Saghir (2002) as, "*The process of planning, implementing and controlling the coordinated packaging system of preparing goods for safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximizing consumer value, sale and hence profit.*"

The definition determines the impact of packaging logistics in the supply chain and hence it is prudent to consider packaging logistics during the new product development phases. The cost of packaging consists of logistical productivity such as handling, storage and marketing, and the cost of the package itself. This cost should be identified at the earlier stages from a logistical viewpoint which would enable savings throughout the marketing system. General Motors in their innovation attempt of returnable plastic packaging realized the potential savings when the suppliers were actively involved in the early packaging of the products (Twede, 1992). This can be characterized as '*systemic innovation*' and requires information flow and co-ordination within the firm and with the suppliers of the product. To achieve systemic innovation, all logistical activities should be considered as factors when making decisions about the logistical packaging. It should be done in a way to facilitate productivity throughout the supply chain which should be balanced by the associated costs and handling across functions of the supply chain (Twede, 1992).

3.2.2. Customs

When companies are trading in international markets, there are many requirements and documentation needed to be fulfilled in order to be able to cross a country's border and sell the goods legally in the country, especially regarding customs declaration. Some countries might have specific requirements and documentations depending on the rules applied by their governments, however there are also some documentations generally needed in almost all countries' customs declaration. Some of those requirements and documentations that are related to the Thesis study will be discussed in this chapter.

- **Rules of Origin**

According to the World Customs Organization (WCO), Rules of Origin is defined as (World Customs Organization, n.d. a):

"The specific provisions, developed from principles established by national legislation or international agreements applied by a country to determine the origin of goods."

Rules of Origin have the role to determine the nationality of given goods, referring to the country the product is made or sourced, and not to be mistaken with the country of provenance, which refer to the countries the goods passed through. Proof of origin for is usually needed to claim the preferential treatment in import/export activities, according to the relevant Free Trade Agreement. It also serves other purposes such as in trade statistics, application of labelling and marking requirements, discriminatory of tariff quotas, and government procurement (World Customs Organization, n.d. a). For countries in European Union, Rules of Origin have become an essential part of EU trade agreements which often apply lower tariffs or customs duties for goods coming from partnering countries, giving advantage for the economic aspect of the business (European Commission, n.d. c).

- **Free Trade Agreement (FTA)**

When it comes to international trading, there could be some barriers related to tariffs for antidumping and safeguard duties, complex customs procedures, burden for administration costs, import licensing, labelling, or packaging requirements, trade defense, insufficient Intellectual Property Right (IPR) protection, and discriminatory treatment compared to national goods (European Commission, n.d. a). In order to ease down and remove those barriers, some countries have agreements in the form of trade agreements. Various benefits could be enjoyed by traders with the existence of trade agreements, such as lower or zero importation tariffs, easier and faster procedures in customs, recognition of product certificates, staff mobility, access to public tenders and better protection for IPR (European Commission, n.d. a).

Trade agreements become very important and are considered a lot when doing import/export activities, especially in the EU. The agreement within the EU market covers 27 member countries and applies the benefit of no customs duties for goods circulating between EU member states, common customs tariff for goods imported from non-EU countries, and no further customs check for goods imported legally when it circulates throughout the EU (European Commission, n.d. a). For Non-EU markets, there have been over 40 agreements signed with almost 80 countries which offer preferential market access to low- and middle-income countries. The agreements are beneficial also to EU countries as the non-EU markets act as important sources of raw materials and goods (European Commission, n.d. a).

- **Harmonized Systems (HS) Codes**

*"The Harmonized Commodity Description and Coding System generally referred to as "*Harmonized System*" or simply "*HS*" is a multipurpose international product nomenclature developed by the World Customs Organization (WCO)" (World Customs Organization, n.d. b).*

The HS nomenclature comprises more than 5,000 commodity groups which are identified by a 6-digit code and is used by more than 200 countries in the world as the basis to determine the Customs tariff and also used for international trade statistics data collection (World Customs

Organization, n.d. b). The HS code is updated periodically to adjust to the classification of products with new technologies and thus it covers over 98% of merchandise in international trade (European Commission, n.d. c). Meanwhile, the EU is implementing an 8-digit HS coding system in order to comprehend further subdivisions and legal notes specifically addressed for EU market needs (European Commission, n.d. c).

However, according to Ding, Fan, and Chen (2015), an accurate and proper HS classification for goods could be difficult to achieve because of three main reasons:

1. HS Complexity - The HS classification and rules are structured in many chapters, but the notes and explanation are meant to assist the customs officers and experts, while common traders might still find the document difficult to follow.
2. Gaps in terminology - There often exists difference in goods description in general market trading and in HS nomenclature, which cannot be solved by keywords searching in the HS document.

3. The evolving nature - Revision for 6-digit HS codes is conducted every five-years period, in addition that some countries could modify the HS codes considered more suitable to them and national HS codes might change several times per year.

3.2.3. Dangerous Goods

The Federal Aviation Administration of USA defines Dangerous Goods (also referred to as hazardous material or hazmat) as "*any substance or material capable of posing an unreasonable risk to health, safety, and property when transported in commerce*".

The United Nations Conference held in 1992 in Rio developed an Agenda 21 Report which was adopted by 150 country heads. This report highlighted the sustainable development responsibilities of member states. Chapter 19 of this Agenda 21 report addresses the management of toxic chemicals or hazardous materials also known as dangerous goods (Pratt, 2002). The conference entrusted the task of developing a globally harmonized hazard (GHS) classification and labelling system. This system could be used for manufacturing, transportation, usage and disposal of chemicals with the help of safety data sheets and understandable symbols (Winder, Azzi, and Wagner, 2005). One of the goals of GHS classification was to facilitate international trade of chemicals across industries and the hazards of these chemicals are assessed and recognized on an international level. The United Nations have classified dangerous goods into 9 classes as shown in Table 3 (Nowacki, Krysiuk, and Kopczewski, 2016):

Table 3 Dangerous Goods classification by United Nations

Class	Definition
Class 1	Explosive substances and articles

Class 2	Gases, including compressed, liquefied and dissolved under pressure gases and vapors
Class 3	Flammable liquids:
Class 4.1	Flammable solids, self-reactive substances and solid desensitized explosives
Class 4.2	Substances liable to spontaneous combustion
Class 4.3	Substances which, in contact with water, emit flammable gases
Class 5.1	Oxidizing substances
Class 5.2	Organic peroxides
Class 6.1	Toxic substances
Class 6.2	Infectious substances
Class 7	Radioactive material
Class 8	Corrosive substances
Class 9	Miscellaneous dangerous substances and articles.

The first step to reduce risk from these goods is identifying them which requires right packaging, communication, handling and storage. The aftermarket products across industries consist of components that are classified as dangerous goods. All supply chains need to ensure the compositions of all products and its right handling. Supply chains across industries consist of 3 flows, which are financial, materials and information (Babin, Kendra and Fazekaš, 2013). The financial flow is beyond the scope of the Thesis research and will not be explored further.

Success of supply chains is highly dependent on its information flow. Some of the information necessary for dangerous goods handling along the supply chains are packaging, labeling, material attributes such as pressure, size and quantity (Babin et al., 2013). This is important as sometimes the quantity of dangerous goods as an individual product might not be hazardous but consolidation of quantities in various combinations might aggregate to large scale risk exposure (Flodén and Woxenius, 2021).

Material flows with respect to dangerous goods requires a Safety Data sheet that needs to be provided by the producer and manufacturers. This is a key information for the transportation of the goods to choose the modes of transportation, restrictions of movement from/via and to places (Babin et al., 2013). Transportation data must include UN DG (United Nation dangerous goods) Codes, data about packaging, marking, labelling, pressures, segregation, size conditions for each material. The correct identification of class of the goods is also crucial, for example class 7 material needs approval by the relevant authority of the country of origin of material, transported through and destination countries (Babin et al., 2013).

UN DG Numbering system United Nations (UN) dangerous goods classification number is a numbering system for the classification of dangerous goods and is universal across multiple transportation. It consists of 4 digits and is important for procurement, transportation and storage of dangerous goods. The UN DG number is very specific and immediately reveals to the handler the labeling requirements, packaging instructions, transportation limitations, hazard classes, specific handling needs, and any possible hazards on reacting to other substances. Hence, identification of the UN DG number needs to be very accurate (Logistics Operational Guide, n. d. a).

Marking and labelling of dangerous goods is extremely necessary throughout the supply chain, specifically warehousing and all forms of transportation. These labels should be visible all times and the cartons/containers storing them and pallets transporting them should all be labelled clearly. The labels should contain UN Number, hazard class labelling and handling labels that specify special handling and considerations (Logistics Operational Guide, n. d. b).

3.2.4. Warehousing

In ideal conditions, a supply chain would have a minimum amount of stock in its pipeline. However, there rarely exists such a perfect supply chain. There are many reasons why keeping stocks is important, such as decouple between supply and demand, safety or protection to uncertain demand patterns and suppliers uncertainty, demand anticipation to seasonal or promotional products and supplier volume discount, trade-off between cost of frequent delivery and cost of keeping inventory, long distance between customers and manufacturers, back-up for any production shut downs, and keeping spare parts for maintenance purpose (Emmett, 2005; Richards, 2017).

Warehouse and the inventory management play strategic roles in fulfilling those reasons. The activities in warehouse operations can be categorized into receiving, storing, order selection and picking/packing, and dispatch (Richards, 2017). High performance warehouse operation is seen crucial to ensure the customers getting the right product at the right time and in the right condition. As supply chain complexity increases and business competition becomes tighter, warehouses are expected to become more efficient in the operation (Richards, 2017). Managers have to seek reliable and effective inventory practices to be able to promote the success of the supply chain (Boone, Craighead, and Hanna, 2008).

There are differences related to the function and policies between managing the service part inventories and traditional manufacturing inventories. Spare part inventory management serves important roles to improve service level and reduce operation cost of supply chain. Topics related to reducing inventory cost, maximizing fill rate, and forecasting demand and volume have become attractive fields in recent years as the concern about high tied up capital and inventory cost is increasing.

According to Emmett (2005), warehouse management should also be involved in the strategic aspect of the business instead of just handling operational day-to-day jobs in order to be able to play its critical part in the supply chain. It includes the involvement in developing future production, product, suppliers, customers, and associated product volumes and throughput. Aligning with it, Richards (2017) discusses an example where input from a warehouse regarding packaging design could give significant influence on the amount of packaging used. Warehouse operation could give input regarding packaging size that would fit to a certain pallet dimension, or how a part is packaged can lead to damage and suggestions on how to best pack a part that will be kept in the warehouse rack.

In the study conducted by Boone et al. (2008), 10 critical challenges faced by service part managers are identified. The challenges also include inaccuracy of service parts forecasts which was stated by all the panel members of the research, lack of a system or holistic perspective, and planning for new product introduction as the eight most ranked challenges. All the 10 challenges are presented in Table 4. Although the challenge of understanding the criticality of each service part did not make it to the top 10 rank, it was stated as one of the challenges that hindered the managers in prioritizing the parts that play important roles to product operation and achieving customer satisfaction. The result of this Thesis study will also revisit the impact of service parts inventory management involvement in the product development phase in overcoming the challenges.

Table 4 Challenges in managing service part inventory (adapted from Boone et al. (2008)

Rank	**Challenges in service part inventories**
1	Lack of a system or holistic perspective
2	Inaccuracy of service parts forecasts
3	Lack of system integration among suppliers, repairers, customers, and service providers
4	Lead time variability
5	Maintaining accurate configuration management and product revision data
6	Minimizing service parts obsolescence
7	Planning for the service requirements of ageing products and the repair of ageing parts
8	Planning for new product introduction
9	Maintaining repair cycle process discipline
10	Planning the location and physical distribution of service parts

3.3. Aftermarket involvement in NPD process

The important aspect in designing the aftermarket supply chain is to plan the strategic moves long before the product is launched (Cohen et al., 2006). It aligns with Goffin and New (2001) who argue that the aftermarket service plays an important role to increase the success rate of new products, thus it needs to be evaluated starting as early as in the New Product Development (NPD) process. The involvement of the aftermarket in product development is considered important in order to add values to the product such as making the product more maintenance friendly (Goffin and New, 2001). Szwejczewski et al. (2015) explained that leading companies are involving the personnel from aftermarket service to the NPD team to ensure that issues related to aftermarket are fully considered in the design stage.

Based on previous research done by Goffin (1998), there are three findings regarding aftermarket involvement in NPD process, which are the late involvement of aftermarket in NPD, the "competition" for resources between aftermarket and other functions to bear the cost of ownership, and the importance of serving quantitative data to R&D related to each requirement to raise the awareness of service-related design goals. The later research (Goffin and New, 2001) identify the importance of: involving aftermarket teams' expertise in NPD, performing comprehensive aftermarket needs evaluation at design stage, monitoring aspects in aftermarket using data management systems, top management commitment to aftermarket, and using aftermarket to create company competitive advantage and increase revenue stream.

Furthermore, companies throughout have also accepted the strategic position of logistics in a product life cycle, however logistics is absent from most literature on NPD (Mentzer, Flint, and Hult, 2001). Zacharia and Mentzer (2007) also argued that involvement of logistics contributes to making decisions of cost trade-offs of logistics effects on a product design. To ensure the trade-offs do not affect the integrity of the NPD process, it is essential for the logistics team to commit and cooperate with the NPD team (Zacharia and Mentzer, 2007).

According to Goffin and New (2001), only four articles discussed the topic of aftermarket involvement in NPD in detail, and even less research related to the topic of aftermarket logistics involvement in NPD. One probable reason mentioned was due to the less attention given by management, thus it also failed to attract the attention of researchers. To the best of the authors' knowledge until this Thesis project was conducted, there have not been many increases in the number of researches to the particular topic, and no framework related to aftermarket logistics requirements has been made until now.

4. Findings and Analysis

This chapter consists of the data acquired through interviews conducted in the focal firm. The interviews were conducted across various departments related to spare part logistics of the firm. The interviews were concerned with the new product development processes and the activities conducted in the functions Packaging, Customs and Trade, Dangerous Goods and Warehouse. The findings of the interviews were analyzed before the final conclusion presented in the next chapter.

4.1. Phases in product development process

The New Product Development (NPD) process in Volvo Group is documented in Develop Product & Aftermarket Product Portfolio (DVP). An NPD could take place when there is a new technology, new product, or product change. It covers the development process of transport solution by Volvo Group consisting of two main offerings:

- **Core products** - including trucks and tractors, buses, coaches and chassis, construction equipment, industrial and marine engines - and the extended product offering - including superstructures, trailers, and used vehicles

- **Vehicle Related Services** for aftermarket products and services. It consists of supporting products and services such as spare parts and warranties, and related products and services such as IT, logistics, or financial services.

In order to achieve successful NPD, the process involves people from different functions and departments including product planning, engineering, manufacturing and logistics, quality and customer satisfaction, purchasing, finance, aftermarket, and brand. The NPD in all projects considers three dimensions, which are Business Dimension, Project Management Dimension, and Development Dimension. The Business Dimension focuses on project profitability and business case, the Project Management Dimension focuses on project commitments and deliverables status, and the Development Dimension focuses on the progress of operational aspects.

The NPD process in Volvo Group follows a stage-gate process where the stages (here referred as phases) of product development are separated by gates which act as checkpoints. Each gate is defined by a set of deliverables that must be achieved to open the gate and allow the project to move forward. The phases and gates in the Volvo Group NPD process are defined as follows.

- **Stage 1**

Pre-PCI The main objective in this phase is to confirm the necessary conditions are in place to start the feasibility study of the product. Overall project investigation and preparation to formally start the project is done in this phase to ensure the balancing, framing, and anchoring of project prerequisites prior to the execution of the project(s). The aspects started to be defined include cost and profitability of the project, time plan, risk management, project organization, technology concept, and other related high-level project scope. The completion of the Pre-PCI phase is marked by the *PCI gate*.

- **Stage 2**

Feasibility Study In the feasibility study phase, project scope in more detailed level is defined by establishing targets related to goals, directives, and prerequisites for hard and soft products. The study also includes developing requirements and alternative solution concepts and evaluating the business opportunity and capability for the whole life cycle of the products or parts, such as development, production, marketing, sales, and other supporting scopes.

In order to complete the feasibility study phase, the deliverables in *Feasibility Gate* (FeG) need to be fulfilled. The deliverables include initiation of product quality management, make or buy list, initial product delivery plan and concept scenarios, identification of production plant, ensure aftermarket involvement, approval of the high-level project scope initiated in Pre-PCI phase, and finalization of project management plan.

- **Stage 3**

Concept Development In this phase, the alternative concepts developed in the feasibility study phase will be analyzed and knowledge gaps among the project members should be closed. Then, one concept that is considered to be able to balance and fulfill customers and stakeholders including manufacturing, logistics, and aftermarket needs will be chosen. Finally, the target of the project must be finalized in this phase. Spare parts judgement is also done in this phase by the Spare Parts Engineers (SPE). The SPE are part of the aftermarket technology in the Product Development team. In the spare parts judgement, the complete attributes of the part such as weight, dimension, and dangerous goods classification should be filled by the Spare Parts Engineering team to the Volvo global system so that other departments who need the information can obtain it. In addition, environmental assurance activity is initiated using a tool to assess environmental risks and optimize environmental opportunities within projects for product and process development.

There are two gates that need to be opened in the concept development phase, which are *Concept Study Gate* (CSG) and *Concept Gate* (CG). In the CSG, line organizations are informed regarding the new products or parts, product architecture and design are planned, Request for Quotation (RFQ) list of early development suppliers are approved, sales and marketing plan as well as aftermarket logistics concept are initiated, and technology concept is finalized. In the CSG, part drawings, environmental assurance, and product certification plans are initiated, product concept and project organization are finalized.

- **Stage 4**

Solution Development In this phase, the transport solution is developed further to create a stable solution and aimed to fulfill customers and stakeholders needs. There are two gates that need to be opened in the solution development phase, which are *Development Gate* (DG) and *Final Development Gate* (FDG). In the DG, development suppliers are awarded and RFQ to production suppliers are initiated if the production suppliers would be different from development suppliers. Product architecture must be finished, and aftermarket logistics solution development is initiated. In FDG, production suppliers will be decided, and production plan as well as physical build are initiated.

- **Stage 5**

Final Verification Phase In this phase, the physical build of the products starts to take place. At the end of the phase, the product, process, and project are confirmed for full industrialization and ready to launch commercially.

In order to close the phase, it must fulfill the *Final Industrialization Gate* (FIG). In FIG, the product certification is initiated, and aftermarket logistics solution implementation starts to take place. The resources for line organization are ensured, following the finalization of product design, production plan, product and spare part release, and environmental assurance actions.

- **Stage 6**

Industrialization and Commercialization The commercial activities including launching and certification are done in this phase. The physical build is saleable with limited volume of production. The ramp-up, supplier's delivery volume for both production and aftermarket including the contract, and logistics, sales and marketing plan are finalized in this phase to support the optimal manufacturing, logistics, commercial, and service and repair activities. By the end of the phase, *Release Gate* (RG) is open.

- **Stage 7**

Follow-up Phase The end phase of new product development includes handover of the project to the line organization for regular production, follow-up project target fulfillment, and finally summarize the experience and close the project. It is marked by the *End Gate* (EG).

The complete NPD process in Volvo Group is summarized in Figure 3 below.

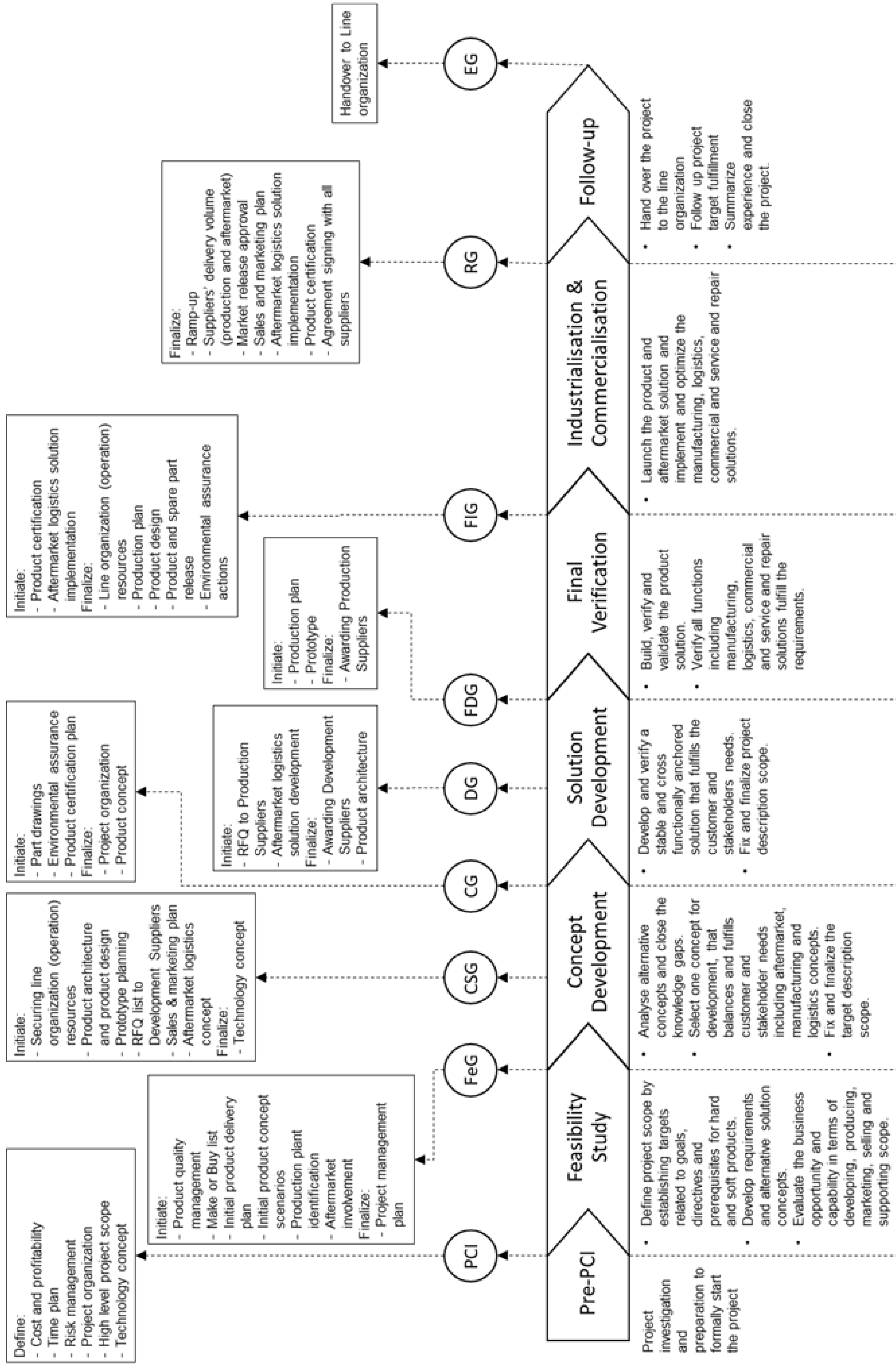

Figure 3 New Product Development phase in Volvo Group

4.2. Aftermarket Logistics

The aftermarket logistics activities and logistics preparation in Volvo Group Trucks Operations (GTO) is handled by a department called Service Market Logistics (SML). The logistics preparedness is an important aspect to support the success of aftermarket business. In recent years, Volvo Group has been expanding its focus on the aftermarket business segment which is considered as the key for their growth. In 2019, the revenue coming from the service segment (including sale of spare parts, maintenance services, repairs, extended coverage, and other aftermarket products) accounted for 23% of net sales and 28% in 2020 (Volvo Group, 2021b). While the growth was due to significant decline in sales of vehicles in pandemic situations, it also shows that the service segment is quite stable since vehicles on road need maintenance to keep them running in optimal condition. Furthermore, there is still a large potential value of spare part sales that has not been captured yet, especially between the second to seventh year of vehicle lifetime, where the needs of spare parts are high and customer loyalty is still above 50%. Moreover, securing the aftermarket business within Volvo is also driven by the profitability reason, customers' needs, and competition and legal environment within the industry.

There are several strategies to grow the spare parts business, which include branding and supplier selection. Branding is considered as a distinguishing factor when products, technologies and services become more and more similar between one company and another. In Volvo Group policy, the spare part branding could be divided into integrated branding in the form of stamping specific brand names on the spare part itself, or sales branding by offering the parts to customers inside a specific Volvo package. In order to execute the branding strategy smoothly, it is important to select the right suppliers. A lifetime focus is important when selecting suppliers, to ensure they will be able to supply the parts not only based on production but also the aftermarket lifetime, volume, and requirements. It should also be noted that suppliers are often the biggest competitors in the aftermarket business, thus legal and contract matters need to get more attention.

Aligned with the company's strategy to expand the aftermarket business, SML sees the necessity to be involved early in the NPD phase in order to secure end-to-end aftermarket supply chain readiness. With early involvement in NPD, SML could secure its requirement fulfilled and have more time to prepare its operation before the product is launched to the market which in the end leads to best customer experience and high customer satisfaction levels. It will also change the current way of working from reactive to proactive and enabling a smooth communication flow between the functions.

This Thesis study focuses on the SML department located in Sweden and Ghent which covers operations in the EMEA region including several functions related to the logistics preparation, which are commercial and transport packaging, customs and trade, dangerous goods, and warehousing. The activities, challenges, and requirements of each function will be discussed in detail in this section.

4.2.1. Packaging

Packaging is considered as an important enabler in the SML supply chain. There are two interrelated functions within packaging, namely commercial packaging and transport packaging. Suppliers are requested to pack spare parts for both commercial and transport purposes whenever possible.

4.2.1.1. Commercial packaging

Commercial packaging function within the SML is responsible for securing cost efficient and high-quality packaging setup for new spare parts and providing continuous improvements in packaging of legacy parts. Commercial packaging is the face of the spare parts to the dealers and ultimately the customers. They determine the packaging solutions by creating Packaging instructions (PI) for all spare parts. PI consists of all packaging data with respect to the spare part number. This makes it a very strategic part of the supply chain of spare parts. The reasons for a spare part to be commercially packed is multiple and these include:

1. Helps fulfill Volvo Group branding requirements.
2. Helps in protection and storage of sensitive spare parts.
3. Creation of sales multiples for inexpensive small parts where individual packaging is not necessary thereby reducing packaging and handling costs.
4. Packaging of kits with multiple components

The function of commercial packaging is finding the balance between cost, quality, environmental impact and ergonomic. This can be achieved only if the decisions related to packaging are taken at the product development process. Currently some of the new parts are still reaching the Central Distribution Centre (CDC) without a packaging decision and a decision is made at the inbound area of the CDC. This leads to additional time and labor for packaging inhouse or outsourcing for the pre-pack process. This is an inefficient and reactive process.

If a packaging decision is made early with the involvement in the product development phase, an improved cost efficiency, reduced environmental impact and increased quality can be secured. Commercial packaging decisions made early lead to packaging requirements inclusion in the Request for Quotation (RFQ) stage during the supplier selection and evaluate suppliers on their capability to accommodate SML requirements. This can lead to accomplishing “Buy As We Sell” (BAWS) packaging by the suppliers from the beginning and avoiding renegotiations later in the life cycle of spare parts when volumes increase. BAWS is a situation when the supplier packs the spare part ready to be sold to the end customer, the product reaches the warehouse packed and, in the condition, to be directly sold to the dealer or end customer. If SML requirements are ignored in the supplier selection phase, Volvo would lose its negotiating power and would lead to expensive deals when requirements are placed at a crucial stage. The BAWS packaging remains intact throughout the supply chain and establishes a consistent and quality assured packaging throughout the lifecycle of the spare parts often ranging up to 15 years. For products with low volume, a BAWS strategy might not be cost efficient. For such cases, early knowledge of forecasted volumes can help commercial packaging determine the alternative packaging of spare parts and make arrangements for 3PL, an external logistics service provider, or inhouse CDC pre-packaging without a major lead time loss. Early involvement can also enable innovative solutions for packaging for parts with special requirements based on the part drawings of the spare parts.

Commercial packaging is very critical for SML and their early involvement is crucial for SML activities to be proactive.

4.2.1.2. Transport packaging

The target for transport packaging is to use the same packaging solution from supplier to CDC (Central Distribution Centre) storage, which means storage specification should be harmonized with inbound transport packaging solution, to achieve “Pack as we store" (PAWS). PAWS is the packaging strategy where the transport packaging is done in accordance with the storage in the warehouse. This helps in a direct flow from the dock to the stock in the warehouse.

Call-off quantity is also necessary to be considered for transport packaging. A call-off quantity is calculated by a material planner based on the Minimum Order Quantity (MOQ), Economic Order Quantity (EOQ), or packaging lot size to be ordered from the supplier. This helps optimize inventory levels and transportation. Inbound transport Packaging Instruction (PI) is needed to guide suppliers to the right packaging type and unit load. The first choice is to find a suitable standard Volvo packaging (VEMB) for parts entering the first CDC.

At times, Volvo packaging might not be a suitable solution for transport packaging especially for spare parts when the call-off quantity is very low, an alternative called One-way packaging is suggested for such scenarios. One-way packaging is used when a VEMB is not a possibility. This should be addressed at the RFQ stage of supplier selection in order to accommodate SML requirements and ensure Volvo does not have a bad negotiation position with the supplier.

VEMB ensures that packaging is consistent with CDC storage. Package engineers create a PI based on the initial stock list and initial stock quantity proposal and reach an agreement with the supplier for the right VEMB size. The PI created in Volvo internal system helps balance the packaging guidelines of Volvo and logistics cost thereby finding the most optimized solution. The packaging engineer then relays this information with the supplier and necessary arrangements are made for “Pack as we store” solutions. Inner packaging is also a key detail for transport packaging. The parts that are not commercially packed by suppliers are needed to be packed for transport and this should support easy handling and ergonomic demands. The packaging engineer needs the part drawings of the spare parts to make this decision. This can be initiated as soon as spare part judgement is made by spare part engineers in the Product Development team.

4.2.2. Customs and trade

Customs and Trade organization (CTEC) is one of the key players in supply chain logistics and has full coverage of the Volvo Group. The topics covered by CTEC organization include customs master data, customs clearance, customs compliance, and trade. Customs master data focuses on managing and improving HS Classification and Country of Origin; Customs clearance focuses on setting import/export and intra community flows; Customs compliance focuses on securing appropriate licenses and customs authorizations and conducting audits to secure and adapt the compliance of the flows; and Trade focuses on trade planning, understanding and managing trade barriers that can impact the project.

The CTEC organization has the mission to provide expertise within customs areas including relevant law and legislations, to govern and optimize customs compliance and mitigate customs risks in accordance with the laws and Volvo policies and directives, and to clear import and export flows in accordance with regulation. However, in accomplishing the missions, CTEC needs to be involved early in NPD process very often the customs activities in order to start their work early and avoid becoming a bottleneck instead. The risk of bottleneck could arise due to the lack of knowledge and information of the new flows, setups, projects, or parts needed to proceed with the customs and trade process.

For the Thesis study, the authors conducted interviews with people within the SML Customs and Trade organization covering Europe, Middle East, and Africa (EMEA) region. Through the interviews, some challenges faced by the function due to late or lack of involvement in the NPD process and the requirements needed to improve the process are identified.

Although the necessity of customs documents and declaration happens when the parts cross country borders, information related to the part itself is needed long before. An important information is related to the country of origin, which mainly could be obtained from the suppliers. The suppliers need to give the information about where the parts are produced and provide a long-term declaration of origin to the customs and trade function in order to be able to manage the preferential status of the parts. When a preferential status is confirmed for a certain part, a tariff reduction or zero tariff could be claimed to the customs office. In relation to that, information about make or buy decisions of the parts and customer market where Volvo will be selling the parts are also needed by SML custom function to check the existence of any Free Trade Agreements between the countries doing the business. The tariff reduction or even zero tariff on customs duties could give a significant economic benefit to both Volvo and their customers.

Another important information needed to be provided to the customs office is the HS classification of the product. The customs function is the one doing the HS classification for each product Volvo is exporting. To do the right classification, some information related to the part is needed, such as parts description, parts type whether it is single part, kits, or sub-assembly because it might affect the parts function and description, and information about preceding HS classification of similar parts if available. The HS classification will also affect the amount of duties paid at customs clearance. Wrong classification could lead to overpaid or underpaid, which has potential to cause problems for Volvo. The HS classification is also utilized by the internal trade function to identify marking requirements, or any trade barriers related to the product. Furthermore, Volvo customers also rely their HS classification to the product based on information from Volvo, thus giving incorrect HS classification would lead to problems on the customer's side as well.

Other requirements include parts specific information like the weight of the part and shipment frequency. The part weight is crucial for the customs function because stating the wrong weight could cause issues while crossing the border. Meanwhile, the shipment frequency is important to prioritize high frequency parts for solicitation and classification as they cross the border more often than other parts.

In order to be able to proceed with customs activities and avoid bottleneck, it would be best for SML customs to gain the information regarding part list and its specification and origin by the Concept Gate where the spare part judgement is done and the detail of the parts can be accessed from the Volvo global system. Then, follow up of all the information required in the Industrialization & Commercialization phase will be beneficial to ensure and finalize the work from customs team. Otherwise, when the information could not be required as early as Concept Gate, then the latest to collect the information would be six weeks before the start of serial production because the investigation and solicitation process and HS classification might take up quite a long lead time. However, it was also noted by the interviewee that for certain products with new technology and new regulation such as batteries and electromobility, the customs function would like to be deeply and early involved in the NPD process to be able to secure the requirements.

The interviewee from the trade function thinks that it is important to have a dialogue with the Purchasing department before the suppliers are selected. The purpose is to ensure the future awarded suppliers' capability to comply with necessary regulations. Another requirement from trade is related to country specific technical requirements to be able to market the products accordingly. Those information include marking requirements, such as CE marking specific to the country, master data of the spare part lists, and safety data requirement. They also need the information whether the suppliers will be the one putting the marking to the product. Thus, it is important to get the information early in the Development Gate before the suppliers are awarded and follow up on the supplier selection process at Release Gate at the latest. The noncompliance to these requirements would be a significant hindrance for Volvo because the products cannot be imported/exported to those certain countries.

4.2.3. Dangerous Goods

Dangerous Goods (DG) function in Volvo Group SML is an expert function that acts as the safety and advisory for dangerous goods and chemical products' handling and storage. The transportation, handling and storing of DG, chemical products, or parts that are considered potentially dangerous are regulated by laws. These regulations often differ with respect to markets and market parts, it is essential to include a DG specialist to ensure the right marking is done on the products based on the regulations in the customer markets.

To ensure the right identification of DG, Volvo has four classifications of goods as shown in Table 5.

Table 5 Classification of Hazardous Goods in Volvo Group

Class	Definition
Class 2	Regulation Unknown
Class 3	Non-Dangerous goods (plastic, steel, glass etc.)
Class 4	Dangerous goods (chemicals products are included) with transportation restrictions
Class 6	Chemical products without transportation restrictions

It is important to note that not all chemical products are dangerous goods. This needs to be identified correctly as handling of dangerous goods has a higher cost and wrong identification will lead to unnecessary costs.

Dangerous goods have an adverse effect on the environment when mishandled, therefore it becomes important to identify these goods in the very early stages of a product development project. Volvo Group has adopted an environmental assurance tool that helps assess environmental risk and optimize environmental opportunities within product development projects. Though there is a presence of dangerous goods in most new projects, currently the tool is not employed for all projects. The involvement of a dangerous goods expert in the decision for application of the Eco-design tool can determine the environmental impact of the dangerous goods and the possible methods to mitigate them.

In GTT, the Spare Parts Engineers in charge of aftermarket create the DG parts and assign the respective codes. The codes 4 or 6 should be assigned for all chemical, dangerous goods or parts that are judged as potentially dangerous. The code 2 is usually avoided unless recommended by a Volvo group DG expert. Identification of DG parts needs a deep analysis, where the information can be acquired from technical documentation of the part. In case the technical documentation is insufficient; the responsible designer or supplier should be contacted for clarifications. When the part is populated as 4 or 6 in the internal Volvo platform, the part needs to be analyzed by a Volvo DG expert and the local DG expert in the Central distribution centers. The local DG experts ensure the storage and handling of DG at the warehouses. If the spare part is assigned 2, 3, 4, or 6 codes then the Volvo group expert also needs to update the Hazmat attributes of the identified goods. The necessity of DG coding is as follows:

1. DG codes are necessary to make decisions about the storage of the goods in the warehouse as there are specific areas that can store dangerous goods and chemical products.
2. Warehouses need specific license permits to store certain products and hence DG codes help determine if the product can be stored in the given warehouse.
3. The right code enables the quality check for the right labelling, packaging, and documentation of the product before it leaves the warehouse. This ensures no product is a hidden dangerous goods which has legal implications when caught by the authorities.

It is also necessary to get information such as weight and product composition of a product deemed as a DG for UFI (Unique Formula Identifier) marking. This is a marking in addition to GHS marking introduced to understand the chemical composition of a product in case of an emergency and is a mandatory marking for health and physical hazards.

The transportation requirements of dangerous goods are different from the normal products. Chemical products and explosive spare parts need a Safety Data sheet (SDS) for transportation that should be provided by the producer of the product. SDS should contain transportation information consisting of a United Nations (UN) number, UN name, GHS classification, environment hazards by the product and mention the precaution needed to be taken by the user. Dangerous parts (parts that are not chemicals) do not require a SDS for transportation, but this information can be acquired from suppliers or internal Volvo DG documents that give information about DG transportation.

Currently at Volvo most of these activities with respect to spare parts which could be classified as DG are identified and performed at FIG of the NPD. This leads to a large number of rush decisions which leads to delays and expenses. Hence, there is a need to increase the focus on compliance of Dangerous Goods and chemical products to ensure:

1. The compliance with legislation and regulations
2. Safe work environment and safe and efficient global distribution
3. Customer deliveries are not stopped or delayed
4. No risk of harming the environment, property, and individuals
5. No risk of legal actions and penalties
6. No risk of reputational loss
7. No risk of losing management system certification of Volvo

4.2.4. Warehousing

Warehousing function in Volvo Group aids in customer service by facilitating high inventory availability, shorter response times, value added services, returns, customization and consolidation. The target is to deliver spare part orders “on time” with the right quality at the optimum price by reducing losses, minimizing waste and ensuring stable performance in a safe workplace. The main activities in the warehouse are divided into inbound, storage, and outbound. The inbound activities include receiving, quality assurance on incoming goods, and pre-packing and kitting; the storage activities include put-away and the storage itself; and the outbound activities include order picking, sorting and packing, consolidating, weighing and cubing, preparing shipping documents, and loading. To be able to run the activities smoothly, coordination is needed not only from internal warehouse functions but also cross-functional coordination with other functions. The Thesis study focuses on the warehouse operation in Ghent CDC (Central Distribution Center) and the requirements to the product development team needed to optimize the warehouse process.

Accuracy of Stock Keeping Unit (SKU) data and location data is important for all incoming parts at the warehouse. It is needed to segregate parts flow according to their characteristics to optimize warehouse space, density, and handling efficiency. The data of the parts could include parts dimension and shape, part number, and technical part drawings. When this information is not assigned to the new parts arriving at the warehouse, they are quality checked then moved to location zero and will remain there until a part number is assigned. Too many parts in terms of volume or type that are placed in location zero will impact the warehouse layout optimization and storage segmentation, which further impacts space utilization and operating cost. The lack of part drawings availability often leads to issues of long and tedious investigation processes when handling customer complaints related to wrong parts delivery. Thus, it is important for the warehouse to receive the data after the aftermarket demands are ensured and before the parts arrive at the warehouse. It is also important to note that the availability of correct data is vital, for example wrong labelling of part numbers might lead to wrong storage assignment and part scrapping upon late identification.

Other than increasing storage density, parts dimension and shape also play a role in packaging, as discussed before in the packaging section. As most of the parts are stored in the warehouse before they are delivered to the customers, the optimum size for both commercial and transport packaging is as important for the warehouse, especially for high volume parts. If the warehouse could get the information early regarding the new parts' dimension and shape, they could give feedback to the product development phase on which packaging suits the most for handling and storing along the supply chain from an operational point of view. The availability of Packaging Instruction for new incoming parts is also important for the warehouse to proceed with packaging and storing decisions. However, the Packaging Instruction is part of the commercial and transport packaging function, thus it is considered as internal coordination instead of a requirement from SML to the Product Development team.

Another valuable information is related to the forecasted volume of the new incoming part. Warehouses need the information to set-up the necessary handling process and space. It is applied especially for high volume parts and large sized parts. On the other hand, when the new incoming part is similar to any old parts or is a supersession part, the warehouse could give feedback regarding the forecasted number to avoid overstock or understock, based on historical demand. The former could affect high inventory and lack of warehouse space and the latter could lead to low customer satisfaction due to insufficient stock.

Related to the storage capacity, a site capacity for each type of goods has been defined and should not be exceeded. However, it is not the case for the current situation. As the number and types of spare parts in Volvo Group are immense, Warehouse does not only handle regular parts but also Dangerous Goods. The criteria and regulation for Dangerous Goods are different from the regular parts, however they are sometimes not given much attention. Dangerous Goods and chemical products should not be stored together with other standard parts. Specific storage conditions apply and specific safety distances might be needed between different types of material. In addition, for chemical products and explosive parts, a safety data sheet must be available to ensure a safe workplace.

The purpose of compliance in handling of Dangerous Goods in warehouses is to secure legal fulfillment as well as safe and efficient handling and transports of Dangerous Goods and chemical products throughout the complete supply chain. Nevertheless, the amount of Dangerous Goods in the warehouse often exceeds the capacity available, requiring additional warehouse space by renting temporary warehouse space. Such a condition is neither preferred nor ideal because there is risk of being non-compliant to storage regulations and increased storage costs of Dangerous Goods in third party storage space. Thus, it is also necessary for warehouses to acquire information about Dangerous Goods and chemical products related to its characteristics, volume, weight, as well as expiry date, especially if it is a new part, in order to be able to decide the handling and avoid high scrap volume.

Also, as mentioned above, the pre-packing and kitting activities are done in the warehouse. Thus, the information if those activities are needed for new incoming parts becomes a requirement from the warehouse that they need to get in hand as soon as the spare part release in the industrialization phase is done. Late information could lead to little or no time to procure ingoing parts and build the kits in the warehouse, which then leads to customer complaints and low customer satisfaction.

5. Results

In this chapter, the results of the Thesis project are presented. It is structured to answer the research questions established in chapter 1. Each research question is answered and presented in the form of a matrix.

5.1. Major Phases in New Product Development (NPD)

In total three interviews were conducted with employees in the Group Trucks Technology (GTT) team in Volvo Group, who are actively involved in the new product development (NPD) process. The aim of the interviews was to identify and understand the NPD process in Volvo Group, what method of NPD is followed, and what are the major phases and milestones targeted in certain phases. The result of the interviews is used to answer the first research question of this Thesis study.

RQ1: *What are the major phases in the new product development (NPD) process in Volvo Group Trucks Operations (GTO)?*

From the interviews, it is identified that the NPD process in Volvo Group follows a stage-gate process, which consists of seven stages and nine gates, with two stages marked by two gates each. Ideally, each phase can be closed and moved to the next stage with accomplishment of deliverables listed in every gate. The list of stages and major activities conducted in each stage are summarized as follows.

- **Pre-PCI** - marked by PCI gate - initiate defining high-level project scope and confirm the necessary conditions are in place to start the feasibility study of the product.

- **Feasibility Study** - marked by Feasibility Gate (FeG) - develop requirements and alternative solution concepts, evaluate business opportunity and capability for the whole life cycle of the products or parts, such as development, production, marketing, and sales.

- **Concept Development** - marked by Concept Study Gate (CSG) and Concept Gate (CG) - alternative concepts are analyzed and reach decision on one concept, knowledge gaps are closed, finalize the project targets related to all functions affected, initiate environmental assurance activity, approve RFQ list of early development suppliers, initiate sales and marketing plan and aftermarket logistics concept, and conduct spare part judgement.

- **Solution Development** - marked by Development Gate (DG) and Final Development Gate (FDG) - Award all suppliers, finish product architecture, initiate aftermarket logistics solution.

- **Final Verification Phase** - marked by *Final Industrialization Gate* (FIG) - finalize environmental assurance actions, ensure resources for line organization, finalize and confirm product design and production plan are ready for full industrialization and commercial launch.

- **Industrialization and Commercialization** - marked by *Release Gate* (RG) - ramp-up, finalize supplier's delivery volume for both production and aftermarket including the contract, and logistics, sales and marketing plan, finish commercial activities including launching and certification; physical build is saleable with limited volume of production.

- **Follow-up Phase** - marked by *End Gate* (EG) - handover of the project to the line organization, follow-up project target fulfillment, summarize the experience and close the project.

The stages and gates of Volvo Group NPD are shown in Figure 4.

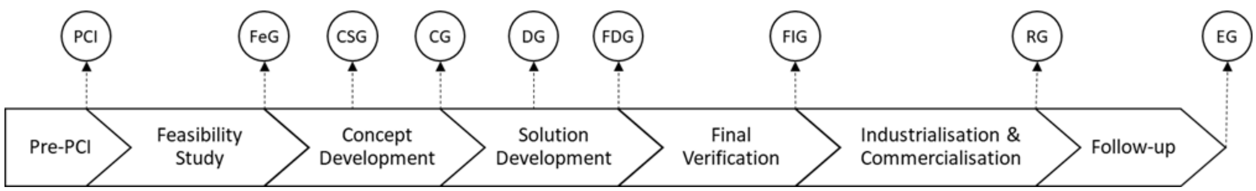

Figure 4 New Product Development Phase in Volvo Group

5.2. Requirements from the Service Market Logistics (SML) Department

A total of 29 interviews were conducted with the employees of the different functions of Service Market Logistics (SML) department. The purpose of the interviews was to identify the current issues faced by these functions and how they can be improved with early involvement in NPD. The result of the interviews helped answer RQ2.

RQ2: *What are the important requirements from Service Market Logistics (SML) that need to be considered in the new product development (NPD) phase?*

The interviews conducted helped us analyze the different gaps that were currently present in the new parts operations of different functions. These gaps resulted in missing information and delays that resulted in a reactive process. Through the interviews the authors analyzed and identified 25 requirements within four functions in the SML. The identified requirements for each function are mentioned in Table 6. The detailed definition of each requirement is presented in Appendix B.

This can be further narrowed down based on the specific project but the requirements mentioned can be broadly used in most projects related to new parts and supersession parts.

Table 6 Requirements identified in SML functions

SML	Packaging	Customs and Trade	Dangerous Goods	Warehousing
Requirements	**Commercial Packaging** 1. Packaging information input to RFQ - Buy As We Sell - Prepacked - Naked 2. Spare part judgement 3. Initial stock part decision 4. Initial forecast 5. Part drawings - Dimension - Shape - Weight - Material **Transport Packaging** 1. Transport Packaging information to RFQ - Standard Volvo packaging - Special packaging - One-Way packaging 2. Initial volume / MOQ / EOQ 3. Spare part judgement	**Customs** 1. Parts Origin - Make or Buy decision - Customer markets - Supplier country of origin - Supplier long term declaration of origin 2. Part Specific information - Weight - Part Classification (HS code) - Shipment frequency 3. Part Type - Single part - Kits - Sub-assembly **Trade** 4. Customer Markets (Country Specific) technical requirements - Markings (CE, etc) - Masterdata - Safety Data 5. Proof of Spare Parts Origin 6. Identification of supplier capability to adhere the right technical requirements	1. Environmental assurance tool 2. Customer Market requirements - Marking requirements - Country specific DG regulations 3. DG classification 4. Product Attributes - Expiry dates - Rust and corrosion[1] - Explosives - Electric hazards 5. Information from Masterdata - Weight[1] - Chemical composition	1. Parts dimension and shape for high volume parts 2. Information about Dangerous Good and liquids - Characteristic - Volume - Weight - Expiry date 3. Forecast volume 4. Technical part drawings 5. Part Number 6. Warehouse-built kits

Note
[1] Service requirement for aftermarket life, not only DG

5.3. Alignment of SML Requirements with NPD Phases

On further analysis it was noticeable that the requirements that were identified will be effective only when executed at the right time. This led to the investigation of the information derived in the NPD phases from RQ1 and led to the answer for RQ3

RQ3: *In which phases of new product development (NPD) should the identified requirements be aligned to?*

The information from the NPD phases were compared with the requirements identified in RQ2 and the fulfillment gate of each of these requirements is shown in Table 7-12. It was noticed that some functions need to submit certain requirements while others need to get information for requirements in the different gates. The major result identified was there is also a need to follow up on the information at later phases to ensure if there are any updates that affect the process of the function.

Table 7 Requirements fulfillment gate for Commercial Packaging

Requirements	**Requirement fulfillment gate**							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Packaging information input to RFQ - Buy As We Sell - Prepacked - Naked			Submit req		Follow up			
Spare part judgement			Get req			Follow up		
Initial stock part decision			Get + Submit req			Follow up		
Initial forecast			Get req			Follow up		
Part drawings - Dimension - Shape - Weight - Material			Get req			Follow up		

Notes
FeG Feasibility Gate
CSG Concept Study Gate
CG Concept Gate
DG Development Gate
FDG Final Development Gate
FIG Final Industrialization Gate
RG Release Gate
EG End Gate

Table 8 Requirements fulfillment gate for Transport Packaging

Requirements	Requirement fulfillment gate							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Transport Packaging information to RFQ - Standard Volvo packaging - Special packaging - One-Way packaging			Submit req		Follow up			
Initial volume / MOQ / EOQ			Get req			Follow up		
Spare part judgement			Get req			Follow up		

Notes

FeG	Feasibility Gate
CSG	Concept Study Gate
CG	Concept Gate
DG	Development Gate
FDG	Final Development Gate
FIG	Final Industrialization Gate
RG	Release Gate
EG	End Gate

Table 9 Requirements fulfillment gate for Customs

Requirements	Requirement fulfillment gate							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Parts Origin - Make or Buy decision - Customer markets - Supplier country of origin - Supplier long term declaration of origin			Get Req			Follow up		
Part Specific information - Weight - Part Classification (HS code) - Shipment frequency			Get Req			Follow up		
Part Type - Single part - Kits - Sub-assembly			Get Req			Follow up		

Notes

FeG	Feasibility Gate
CSG	Concept Study Gate
CG	Concept Gate
DG	Development Gate
FDG	Final Development Gate
FIG	Final Industrialization Gate
RG	Release Gate
EG	End Gate

Table 10 Requirements fulfillment gate for Trade

Requirements	**Requirement fulfillment gate**							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Customer Markets (Country Specific) technical requirements - Markings (CE, etc) - Masterdata - Safety Data*				Get Req			Follow up	
Proof of Spare Parts origin					Get Req			
Identification of supplier capability to adhere the right technical requirements.				Get Req				

Notes

FeG	Feasibility Gate
CSG	Concept Study Gate
CG	Concept Gate
DG	Development Gate
FDG	Final Development Gate
FIG	Final Industrialization Gate
RG	Release Gate
EG	End Gate

Table 11 Requirements fulfillment gate for Dangerous Goods

Requirements	**Requirement fulfillment gate**							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Environmental assurance tool			Involve in decision making					
Customer Market requirements - Marking requirements - Country specific DG regulations			Get Req			Follow up		
DG classification			Get Req			Follow up		
Product Attributes - Expiry dates - Rust and corrosion[1] - Explosives - Electric hazards			Get Req			Follow up		
Information from Masterdata - Weight[1] - Chemical composition			Get Req			Follow up		

Notes

FeG	Feasibility Gate
CSG	Concept Study Gate
CG	Concept Gate
DG	Development Gate
FDG	Final Development Gate
FIG	Final Industrialization Gate
RG	Release Gate
EG	End Gate

Table 12 Requirements fulfillment gate for Warehousing

Requirements	Requirement fulfillment gate							
	FeG	**CSG**	**CG**	**DG**	**FDG**	**FIG**	**RG**	**EG**
Parts dimension and shape for high volume parts			Get Req			Follow up		
Information about Dangerous Good and liquids - Characteristic - Volume - Weight - Expiry date			Get Req			Follow up		
Forecast volume			Get Req				Follow up	
Technical part drawings							Get Req	
Part Number							Get Req	
Warehouse-built kits						Get Req		

Notes

FeG	Feasibility Gate
CSG	Concept Study Gate
CG	Concept Gate
DG	Development Gate
FDG	Final Development Gate
FIG	Final Industrialization Gate
RG	Release Gate
EG	End Gate

5.4. Consequences of Late Involvement of SML

To involve SML earlier in the NPD process might be seen by the Product Development team as an activity that only adds complexity to the process. Thus, it is important for SML to be able to show the reasoning of their early involvement in the NPD process. The analysis includes the challenges currently faced by SML due to late involvement in the NPD process and consequences of not having the requirements fulfilled. The result then provided the answer to the last research question.

RQ4: *What are the consequences of not involving Service Market Logistics (SML) in the new product development (NPD) phase?*

RQ4 focuses on the consequences of not fulfilling the requirements identified in RQ2 as shown in Table 13-18. It is also important to ensure that these requirements have to be fulfilled at the right time as seen in RQ 3 and hence the possibility to eliminate the consequences.

Table 13 Consequences of not fulfilling requirements for Commercial Packaging

Requirements	**Consequence of not fulfilling requirements**
Packaging information input to RFQ - Buy As We Sell - Prepacked - Naked	- Bad negotiation position for Volvo when the packaging requirements are identified at a later stage (when supplier has been awarded with the contract): • higher price per product • supplier refuses to accommodate commercial packaging requirements - Changes will be difficult to make and higher cost occurs at CDCs for packaging and pre-packaging - To avoid quality issues and longer lead times
Spare part judgement	Hindrance to start commercial packaging process
Initial stock part decision	- Failure in identifying parts that need to be prioritized - Unable to compare cost of BAWS and repackaging by 3PL
Initial forecast	No possibility to - Prioritize high volume parts for BAWS - Identify sales multiples - Develop optimized packaging design - Optimize warehouse storage and transport - Negotiate with suppliers
Part drawings - Dimension - Shape - Weight - Material	Late decision making for Packaging Instruction

Table 14 Consequences of not fulfilling requirements for Transport Packaging

Requirements	Consequence of not fulfilling requirements
Transport Packaging information to RFQ - Standard Volvo packaging - Special packaging - One-Way packaging	- Late agreements on the costs related to packaging during RFQ based on the Volvo packaging stock at the supplier - Difficult negotiations with the supplier in the detailed level - Quality issues due to high number of handling - Higher cost of 3PL utilized for re-packaging in warehouse - Increase in lead time due to multiple handling needed in warehouse
Initial volume / MOQ / EOQ	No possibility to - Prioritize high volume parts for BAWS - Develop optimized packaging design - Optimize warehouse storage and transport - Negotiate with suppliers
Spare part judgement	Hindrance to start transport packaging process

Table 15 Consequences of not fulfilling requirements for Customs

Requirements	Consequence of not fulfilling requirements
Parts Origin - Make or Buy decision - Customer markets - Supplier country of origin - Supplier long term declaration of origin	- Not be able to deliver the cost savings to customer due to not identifying the right to claim tariff reductions - Long lead times for solicitation process
Part Specific information - Weight - Part Classification (HS code) - Shipment frequency	- Wrong weight causes issues while crossing the border - Wrong classification can lead to wrong amount of import duty fee paid at customs
Part Type - Single part - Kits - Sub-assembly	- Wrong classification leads to wrong amount of import duty fee paid at customs - Wrong information in all Volvo and customer systems

Table 16 Consequences of not fulfilling requirements for Trade

Requirements	Consequence of not fulfilling requirements
Customer Markets (Country Specific) technical requirements - Markings (CE, etc) - Masterdata - Safety Data	Parts will be considered non-compliant and unable to import/export to certain countries
Proof of Spare Parts origin	Not able to claim tariff reduction
Identification of supplier capability to adhere the right technical requirements	Risk of not to be able to import/export the parts

Table 17 Consequences of not fulfilling requirements for Hazardous Goods

Requirements	Consequence of not fulfilling requirements
Environmental assurance tool	Service disruption/stop in service
Customer Market requirements - Marking requirements - Country specific DG regulations	- Last minute rush markings/decisions (safety data sheets) regarding local regulations - Wrong labelling for a certain geographical area - Risk of fine - Service disruption/stop in service
DG classification	- Redundant work due to wrong numbering non DG as DG - Extra work in warehouse and DG function due to wrong numbering DG as non DG - Accident due to wrong handling of DG - Extra cost due to over-handling of non DG (such as surge charge in transportation) - Service disruption/stop in service - Risk of fine
Product Attributes - Expiry dates - Rust and corrosion[1] - Explosives - Electric hazards	- Unnecessary scrap due to wrong handling - Service disruption/stop in service
Information from Masterdata - Weight[1] - Chemical composition	- Service disruption/stop in service - Wrong handling of DG

Note

[1] Service requirement for aftermarket life, not only DG

Table 18 Consequences of not fulfilling requirements for Warehousing

Requirements	Consequence of not fulfilling requirements
Parts dimension and shape for high volume parts	- In-efficient storage space in Warehouse - Longer lead time for putting the information to the system when part arrives in the warehouse without information
Information about Dangerous Good and liquids - Characteristic - Volume - Weight - - Expiry date	- Risk of being non-compliant to storage regulations - Additional cost to outsource Dangerous Goods storage - High scrap volumes if expiry date is not considered while making storage decisions
Forecast volume	- When the quantity sold is higher than forecast, Volvo warehouse does not have enough parts on stock; leads to low customer satisfaction - When the quantity sold is lower than forecast, Volvo warehouse has too many parts on stock and does not have enough space to store
Technical part drawings	- Long (weeks to months) and tedious investigative process when a non-compliant part (according to customer) is identified - Impact on availability of parts when an issue is raised by the customer and a part drawing is not readily available
Part Number	Wrong labelling of part number might lead to wrong storage thereby scrapping the part upon late identification
Warehouse-built kits	Late information leaves short/no time to - procure ingoing parts - build the kit in the warehouse which leads to customers complaints
Build-to-stock vs Build-to-order decision	When large products are built to stock then the warehouse space is compromised, hence built to order can be prioritized for such products based on demand of the product

The RQs are answered but we noticed that most of the functions are interrelated and support to each other and often require to fulfill the requirements around similar time frame and this would be further discussed in the next section.

6. Discussion

This chapter contains the comparison of the results with relevant literature. The discussion starts with general topics followed by managerial impact and process impact.

The authors first compared the Cooper's Stage - gate model and Volvo's NPD process and noticed that it was very similar. This is shown in Table 19. Cooper described his model as a building stone for NPD processes that can be customized according to a firm's requirement. This was clearly noticed in Volvo's NPD model where components of each stage were tailored to the firm. The authors also noticed that there were some overlaps in stages in the Volvo NPD process compared to Cooper's model. For example, the definition stage of Cooper's model consists of both the feasibility stage and the concept development stage of the Volvo NPD process.

Table 19 Comparison of NPD phases between Cooper (1990) and Volvo NPD

Cooper's Model	Volvo's NPD process	Description
Idea Generation	Pre- PCI	Defining high-level project scope
Preliminary assessment	Feasibility Study	Assessing potential markets etc.
Definition stage	Late Feasibility Study and Concept Development	Define clear solution/concept that is economically and technically feasible
Development stage	Solution Development	Concern about marketing plan, operation plan and production plan
Validation stage	Final Verification stage	Final verification of the product, product is ready, open for full commercialization
Commercialization	Industrialization & Commercialization	Product launch and related activities
Post implementation review	Follow up	Product review and assessment

It should be noted that both theoretical framework and Volvo NPD process, the process is continuous and not discrete, so sometimes the separation between stages and gates are not very strict, one could overlap with each other.

It has also been noticed by the authors that no single literature discusses all the functions studied in this Thesis study as one complete part that builds the aftermarket logistics function. Cohen et al. (2006) mentioned that the network of the aftermarket supply chain consists of: parts as the material; people including engineers, call center staff, depot and warehouse staff, and transportation staff; and infrastructure for materials movement and storage, repair, transportation, information systems and communication. For the rest of the functions, the authors compiled the literature study from different fields which in the end cover a very broad scope. In other words, the functions considered important and strategic by the Volvo Group responsible to ensure the aftermarket readiness are not recognized yet in the literature of the aftermarket field of study. Even so, the main roles and activities in the daily operation of each function are not much different from what is discussed in literature, whether it is specific to spare parts handling in the automotive industry.

6.1. Managerial Impact

Based on the study done by the authors, it can be concluded that the NPD process in Volvo Group is mostly aligned with the theoretical framework of NPD by Cooper (1990). Although in the theoretical framework itself it was not discussed in detail regarding aftermarket involvement, in the Volvo NPD process guideline the aftermarket is stated even in the early phases. The aftermarket concept, and in specific aftermarket logistics concepts are initiated in the Concept Development phase. However, it is not the case in practice, as SML is involved at later stages in many projects. As discussed by Szwejczewski et al. (2015), the key factors of a product include a well-defined NPD process, presence of cross-functional teams in various stages of NPD process, and right apprehension of customer needs. Volvo Group, GTO in specific, has implemented the first and third factor, however it is still lacking on the implementation of the second factor, namely presence of cross-functional teams in various stages of the NPD process. Not only the Product Development teams need to start involving SML in the process, but SML should also start the initiative to inform themselves to the team, as they are trying to move from reactive to proactive way of working. Another important key success also lies on the commitment and support from management to enable the change.

As also discussed in the previous section, the timing of SML involvement into NPD projects is crucial. In that way, the proactive way of working does not stop in requesting to be involved and handed in the requirements, but to know in which phase each function needs to join. In the current situation, some functions are neither very familiar with the terms related to the NPD process nor have good understanding about the gates, raising uncertainty to which phase they need or want to be involved.

It is also noticed that most of the requirements are needed in the Concept Development phase, as it is related to the spare part judgement activity. The spare part judgement is where the spare parts going to be sold in aftermarket have been decided and most of the information related to the parts such as part attributes are first available in the global Volvo system accessible by other functions including SML. It is then reasonable for SML to obtain the information as many processes and procedures to prepare for aftermarket readiness are related to the part information. The part specification might undergo some changes along the solution development and final verification phase; thus, it is needed to follow up the information at the Final Industrialization Gate (FIG). This also aligns with Cooper's (1990) framework as the Validation stage should go through a wide range of activities to ensure the commercialization prerequisites are met.

6.2. Process Impact

The Thesis study introspected the process that currently exists in Volvo SML activities and identified that there is a dire need of exchange of information. Most of the requirements that were identified during the course of the Thesis work were mostly concerned with receiving the information at the Concept Development phase which is marked by the Concept Gate (CG). The authors also realized the importance of following up on the information received, at the Final Industrialization Gate (FIG). This is essential as the products are ready to launch post FIG and the changes made since CG can be captured and corrected. This ensures that all the functions are prepared to accommodate changes if necessary.

The authors also noticed that the SML functions can be included in the NPD process without being a hindrance to the development process by relaying the information to the functions at CG. The functions studied, Packaging, Customs and Trade, and Warehouse predominately just need the information regarding spare parts from the NPD process. This information exchange can also help these functions to raise a red flag when a spare part design could be problematic at a later stage. This helps counter this issue at an early stage and avoid a backlash later in the process. It was also noticed that the Dangerous Goods function needs a more direct involvement with the NPD process as they need to make decisions with respect to the environment assurance tool and ensure the environmental impact of the spare part is within the directives of EU legislation.

The authors also recognized the requirements sometimes were cross functional. For example, the HS Classification required for trade activities were provided by the Customs. The Packaging Instructions required by Warehouse to make decisions related to pre-packing activities and storing activities were prepared by the Packaging function. This also illustrates the need for receiving the information early. A delay in information delays the subsequent processes.

It was also interesting to see that most of the requirements were similar across functions. Requirements such as the origin of spare parts, customer markets, product characteristics and dimensions are constant in most of these functions. The identification of these requirements enables them to be captured by the NPD process and relayed to the right function. Thus, despite the number of total requirements requested by SML to the Product Development team, it would not hinder the processes of the NPD. Firstly, because most of the requirements request only information which does not interfere with the process. Secondly, most of the requirements are dependent on the spare part judgement.

7. Conclusion and Future Research

This chapter concludes the thesis study and establishes the importance of the research to the focal firm. Post the conclusion, a future research section is also included to establish the possibilities of the study in future research.

7.1. Conclusion

The purpose of this research was to establish the importance of the involvement of the aftermarket logistics in the New Product Development (NPD) phases. The authors studied the existing process of aftermarket logistics and its presence in the NPD. This was done through a series of interviews across aftermarket department of Volvo. The first set of interviews led to the formulation of four research questions, and they are answered through the course of this Thesis. The research questions are as follows.

RQ1: *What are the major phases in the new product development (NPD) process in Volvo Group Trucks Operations (GTO)?*

RQ2: *What are the important requirements from Service Market Logistics (SML) that need to be considered in the new product development (NPD) phase?*

RQ3: *In which phases of new product development (NPD) should the identified parameters be aligned to?*

RQ4: *What are the consequences of not involving Service Market Logistics (SML) in the new product development (NPD) phase?*

The answers to these questions are discussed and answered in chapter 5. A second set of interviews were later conducted with selected interviewees to present the answers and get a feedback. The answers were then modified to incorporate the feedback received. The interviews covered the perspective of both aftermarket logistics and product development. This helped the authors to identify the requirements that would be applicable to SML functions without compromising the product development processes.

During the research, the authors discovered that most of the challenges related to spare parts logistics occurring at later stages were instantly dealt with by the aftermarket functions sometimes even at excessive cost. This ensured that the spare parts logistics did not become a bottleneck to the processes in Volvo. But resulted in missing opportunities on considering the aftermarket as a strategic advantage. As mentioned earlier the functions considered for the study are strategic to the SML department of Volvo Group. Packaging function consists of both commercial and transport packaging. This function ensures the spare parts are optimally packed for transportation and retailers, enabling storage and handling. Customs and Trade functions facilitate the smooth movement of spare parts across the globe. Dangerous goods function enables to minimize the risk of these spare parts on the environment and finally Warehousing function ensures the availability of the spare parts. All these functions when correctly optimized would give Volvo a competitive advantage in the aftermarket segment.

While researching the authors recognized the presence of documentation of aftermarket involvement in NPD in Volvo's internal documents but there was a lack of management awareness and hence a lack of implementation. The research intends to bring out this awareness to ensure that aftermarket logistics can be optimized and recognized as a strategic advantage. To bring forth the cognizance of the aftermarket logistics functions, a matrix was developed. This matrix consists of the requirements of the functions, the time of fulfillment and the consequences of not fulfilling the requirements. The comprehensive matrix is available in chapter 5 and the Appendix B of the report.

The authors created a generalized matrix to ensure that it can be used in most new parts and supersession parts. It can be further modified for specific projects. These identified requirements and its implementation are the first step to transform the aftermarket logistics way of working from a reactive process to a proactive process.

7.2. Future Research

As the Thesis study has limitations in scope and time, there are some aspects that could be added and evaluated if Volvo Group is going to continue the study further or conduct a similar study for other parts of the company. In the future research, the company needs to consider not only qualitative aspects but also the quantitative aspects. In this Thesis report, the authors have limitations to obtain the figures related to lost or excess expenses due to SML late involvement in the NPD process. One reason is because the functions within SML are not keeping the numbers as their performance indicators, and another reason is because it is a challenge to define cost savings resulting from making better decisions during the NPD process.

For the continuation of the research, there needs to be follow-up on the matrix presented in this Thesis study. First follow-up is related to the validity of the requirements themselves, whether it is considered reasonable from a Product Development point of view to involve SML and provide information in the required stages. Second, as the Thesis study stopped at developing the matrix, the follow-up should observe the improvements enabled from both Product Development and SML point of views related to how the matrix could help in facing the current challenges and contribute to both cost savings and the better way of working in the whole NPD process.

In addition, to conduct a similar research as this Thesis study, a benchmark would be beneficial to enrich the company's knowledge and expectation related to the topic. There are several options for the benchmarking objects. The easiest and simplest would be to benchmark internally to other departments that currently have already been involved in the NPD process, for example the Production Logistics department which prepares the logistics readiness for line production matters. Next option would be to benchmark similar departments in other companies within the same industry, i.e., the commercial automotive industry, which might have involved their aftermarket logistics in the new product development process. Another option is to benchmark similar departments in other companies with different industries to explore the best practice.

From an academic point of view, as also discussed before, there has been no framework related to the involvement of aftermarket logistics to the new product development process in internal companies. There has been very little research discussing the aftermarket involvement in NPD but not from the logistics perspective, and when it comes to aftermarket logistics, the researchers are more focused on the operational excellence and downstream part of the supply chain. Thus, this Thesis could be considered as an addition to existing research and a relatively new field to explore. However, as this Thesis study is conducted as a case study, many aspects are very specific to Volvo. One main aspect is the functions studied, which are commercial and transport packaging, customs and trade, dangerous goods, and warehousing. These functions are considered strategic by Volvo Group to ensure the aftermarket readiness, but other companies might see it differently. Hence, if other researchers are going to conduct a similar study, it should be noted that the functions included in the study are not strict and limited to the functions included in this study.

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Appendix

Appendix A Interview list

Commercial and Transport Packaging

1. Commercial Packaging Best Practices Manager
2. Commercial Packaging Manager, Europe
3. Logistics Engineer – Transport Packaging

Customs and Trade

1. Customs Developer
2. Head of Trade Management

Dangerous Goods

1. Head of Quality & Environment
2. Dangerous Goods and Chemicals Specialist

Warehousing

1. Group leader Warehouse Optimization
2. Logistics Engineer
3. Packing engineer
4. Quality Assurance Coordinator

Product Development

1. Section Manager – SPAE
2. Business Process Developer
3. Senior Spare Parts Engineer

Others

1. Export Control Process Manager
2. SML Product Preparation Manager
3. Phase-in coordinator
4. Process Manager concerning VOC and complete E2E thinking in SML
5. Senior Excellence Manager at Operation Excellence
6. Logistics Manager Sourcing
7. Strategy & Senior Project Manager , ESS batteries/Electromobility
8. QJ & Quality Campaign Coordinator
9. Logistics Product Project Manager - 1
10. Product Project Manager
11. Project Manager – Lyon

12. Logistics Product Project Manager - 2
13. Manager Material Planning

Appendix B SML Requirement in NPD process

B.1 Requirements identified in Commercial Packaging

SML function	Requirements	Definition
Commercial Packaging	Packaging information input to RFQ - Buy As We Sell - Prepacked - Naked	Information related to how supplier will send new parts to Volvo - To enable creation of Packaging Instructions for critical and strategic parts - To avoid making packaging decisions in the inbound area of CDC - To make preparations for pre-packing activities at CDC in relation to inhouse or 3PL - To optimize from current packaging solutions
	Spare part judgement	The decision of spare parts assortment that acts as a trigger - To commence the packaging process - To prioritize which parts to work on packaging decision
	Initial stock part decision	Information needed to recognize: - critical part on shelf - forecast of the initial volume - to make decision of preferred packing from supplier (very low volume parts do not need BAWS by supplier)
	Initial forecast	To help in decision making for - sales multiple identification - prioritization to pursue BAWS - 3PL pre-pack for low volume parts
	Part drawings - Dimension - Shape - Weight - Material	Part drawings as an input to make right decisions regarding the commercial packaging

B.2 Requirements identified in Transport Packaging

SML Function	Requirements	Definition
Transport Packaging	Transport Packaging information to RFQ - Standard Volvo packaging - Special packaging - One-Way packaging	High level information about Transport Packaging - To enable creation of Packaging Instructions for critical and strategic parts - To decide who will bear the cost of packaging - To fit the parts with standard Volvo packaging - To enable storage in CDC in a standard way
	Initial volume / MOQ / EOQ	Information needed to: - Define unit load for transportation handling - Enable to increase filling rate - Potential improvement related to decision of "Pack As We Store"
	Spare part judgement	The decision of spare parts assortment that acts as a trigger to know which parts to dress with packaging requirements

B.3 Requirements identified in Customs

SML Function	Requirements	Definition
Customs	Parts Origin - Make or Buy decision - Customer markets - Supplier country of origin - Supplier long term declaration of origin	Information needed to - Calculate origin of the part - Anticipate the tariff reductions or zero tariffs according Free Trade Agreements - To manage the preferential status of the parts
	Part Specific information - Weight - Part Classification (HS code) - Shipment frequency	Information needed to initiate customs processes - The preceding part classification is identified to avoid different classification on new parts - Prioritize high frequency parts for solicitation and classification as they cross borders often
	Part Type - Single part - Kits - Sub-assembly	Information needed for the classification of the parts, helps in identification of the function of the part

B.4 Requirements identified in Trade

SML Function	Requirements	Definition
Trade	Customer Markets (Country Specific) technical requirements - Markings (CE, etc) - Masterdata - Safety Data	Information needed - To take decision whether marking will be done by Volvo or the Suppliers - To market products accordingly
	Proof of Spare Parts origin	Information needed to fulfill criteria to achieve tariff reductions or zero tariffs according Free Trade Agreements
	Identification of supplier capability to adhere the right technical requirements	Requirements from Trade organization to Purchasing to ensure supplier compliance towards all necessary regulations

B.5 Requirements identified in Dangerous Goods

SML Function	Requirements	Definition
Dangerous Goods	Environmental assurance tool	Decision to perform EcoDesign tool for new projects
	Customer Market requirements - Marking requirements - Country specific DG regulations	Specific information needed to sell in countries - To ensure right marking
	DG classification	Information needed by DG functions related to the new part in order to be able to classify it to the right DG numbering (2,3,4,6)
	Product Attributes - Expiry dates - Rust and corrosion[1] - Explosives - Electric hazards	Information needed to make decision on - Prioritizing DG labelling for parts with shorter shelf life - Handling, storage and transportation of parts prone to rusting and corroding, explosion, and electric shocks
	Information from Masterdata - Weight[1] - Chemical composition	The information in Masterdata needed to be verified by inspection to ensure all data are correctly captured

Notes

1 Service requirement for aftermarket life, not only DG

B.6 Requirements identified in Warehousing

SML Function	Requirements	Definition
Warehousing	Parts dimension and shape for high volume parts	Feedback from Warehouse to optimize packaging size - To fit into standard pallets - To increase density for storage
	Information about Dangerous Good and liquids - Characteristic - Volume - Weight - Expiry date	Information to decide handling due to limited storage space in Warehouse for Dangerous Goods and liquids
	Forecast volume	Feedback on historical demand to optimize warehouse activities (handling, storage space, scrapping) of: - High volume products - Large size parts
	Technical part drawings	Document issued by suppliers containing the specific part drawings and information regarding weight and dimensions to ensure the products delivered to warehouse are compliant
	Part Number	Information to identify parts and allocate a storage location in the warehouse
	Warehouse-built kits	Information regarding the parts that need to be built into kits at the warehouse

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