CHALMERS

Transforming customer needs to technical requirements

-Study of a new product development case at Volvo Car Group

Master of Science Thesis in the Master Degree Programme, Product Development

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[Product-service systems – from customer needs to requirements in early development phases. (Larsson, 2009)]

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Preface

This report has been produced as a master thesis at the Department of Product Strategy & Vehicle Line Management at Volvo Car Corporation, Gothenburg, Sweden. The project was conducted in cooperation with the Department of Product and Production Development at Chalmers University of Technology in Gothenburg.

The idea for writing a master thesis about product development and requirement setting is a result of an enhancement of Volvo Cars product development process where customer research today is a developing field. Based on this fact, the report's focus is to examine the product development process and how customer requirements are transformed into a technical product specification.

There are many people I would like to thank and acknowledge for valuable help and support during the project. First I want to thank my supervisor at Volvo Cars, Mr Henrik Green, for the chance to do this project and for support throughout the project. I want to thank my supervisor at Chalmers University of Technology Dr Göran Gustafsson for the constructive feedback and openness he has given in the scientific discovery process that has characterized the work. Furthermore, I would like to thank Ms Eva Fred for valuable discussions, support and help during the project. I would also like to give special thanks to the people who participated in interviews, these people's help and knowledge has contributed much to the content and relevance of the report.

Eva Andersson, Gothenburg, Sweden, May 2014.

Abstract

The high demands placed on the automotive industry makes it essential for companies to ensure consistent success in developing new products by understanding customer needs and developing products desired by the customers. It is however complex to work with customer needs and requirements largely depending on the fact that customers' preferences change and that customers do not know what they want in the future. To address these obstacles it is important to work effectively with requirements management and create a standardized process to ensure that customer needs are prioritised during the development process.

A new car project has recently been initiated at Volvo Cars. For this project the product development process has been changed and a comprehensive explorative customer research has been performed early in the project to obtain more data about customers and their needs. Based upon this the aim of the report is to identify established customer requirements and investigate how this information is used during the development process.

The content in the report is mainly based upon observations and an interview study executed at Volvo Cars. As a complement to the empirical information literature studies was conducted, and finally the empirical data was connected to theories in order to analyse the case, draw conclusions and to be able to provide recommendations.

The report shows that the changes in the process at Volvo Cars with using a broader, cross-functional team at the customer research have resulted in a more widespread and recognised product definition. There exists an obvious difference of opinion regarding the product definition which generally can be summarized by stating that those who are closely linked to the product definition find it effective while those belonging to the development side find the definition tedious and vague. This suggests that even though the product development process to a certain extent has improved, there is further potential for development; a more distinctive product definition would have been desirable where one could benefit even more from the use of a cross-functional team.

Key Words: *Automotive industry, customer needs, design methodology, product development, requirements management*

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Abbreviations

BIC	Best In Class
BMS	Business Management System
BRIC	Brazil, Russia, India, China
CV-spec	Complete Vehicle Specification
EMT	Executive Management Team
LAD	Learning Administration system
MSS	Marketing, Sales and Service
NCAP	New Car Assessment Programme
OEM	Original Equipment Manufacturer
PMM	Product Matters Meeting
PS&VLM	Product Strategy and Vehicle Line Management
PS	Program Start
PSF	Program Strategy Finalised
PSI	Program Strategy Intent
R&D	Research and Development
RoW	Rest of the World
VCC	Volvo Car Corporation
VMCC	Volvo Monitoring and Concept Center
VPDS	Volvo Product Development System

1 Introduction

The opening chapter first presents a background to the thesis project, provides a description of the company that is the object of study, gives a short introduction to the company's situation today and the intention with the project. Against this background the purpose of the report is defined. Subsequently the next section presents delimitations that have been made regarding the content and scope of the report. Lastly, based on the purpose of the report, research questions are formulated.

1.1 Background

After a few difficult years, the automotive industry is now on the rise and the positive trend is expected to continue, see Figure 1.1. By 2020 the OEMs are predicted to increase their profits by nearly 50 %, where it is mainly profits from emerging markets that are estimated to grow (Mohr et al., 2013). However the competition on the automotive market is fierce; many actors are competing over the same customers thus keeping the prices down and in Europe as well as in China the industry suffers from overcapacity.

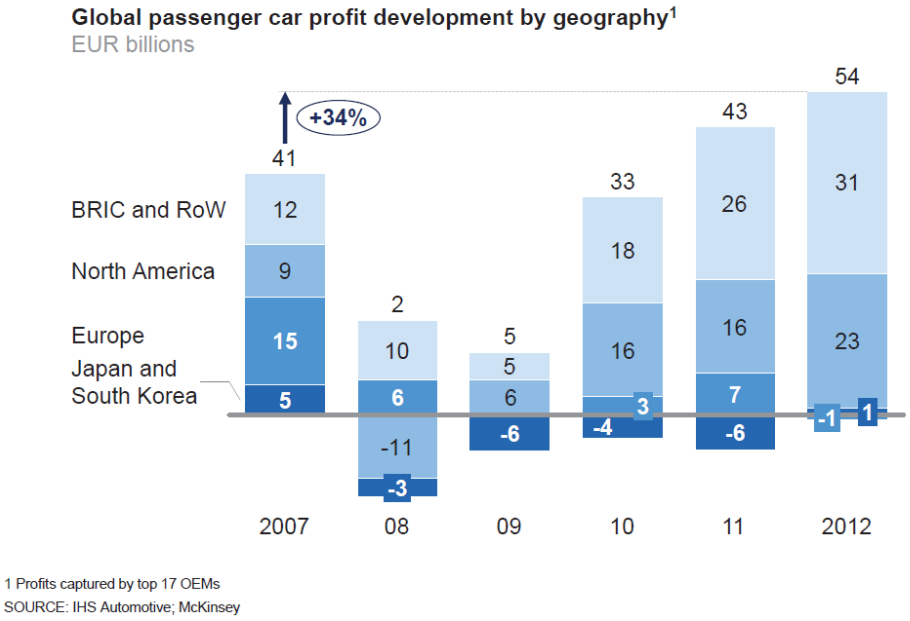

Figure 1.1 Profits in the automotive industry have recovered since the crisis and in addition the distribution between markets has changed. The market is divided in segments as follows: Europe (excluding Russia), North America (US, Canada, Mexico), Japan and South Korea, the BRICs (Brazil, Russia, India, China), and the rest of the world (RoW) (Mohr et al., 2013).

Future challenges involve meeting cost pressure, complexity, shifting technologies, diverging markets with changes in supply and demand (Mohr et al., 2013). To meet new challenges companies need to change their strategies, it will become harder and harder for premium players to differentiate themselves from competitors by introducing new derivatives and increasing the product portfolio. Premium brands must therefore consider how to differentiate and how to increase the customer experience in order to get a better chance of succeeding in the future.

The high demands placed on the automotive industry also make it essential for each organization not only to create one successful product but to secure persistent success companies must ensure a consistent success in developing new products (Wheelwright & Clark, 1992). This means that companies must develop the product development process in order to stay competitive. Furthermore, to be competitive companies must ensure a strategic alignment where the companies operation's resources must be aligned with the market requirements. There is a need to reconcile the market and resource perspective to get an overall picture of what the company can do in relation to the market and try to find an optimal strategy. Finding and maintaining a balance between operations resources and markets demands is critical but at the same time a hard task to succeed with. The difficulty depends largely on the fact that here lies an inherent conflict; operations resources are difficult to change, technically limited and market demands on the other hand are dynamic, heterogeneous and difficult to find out. To succeed and to keep ones market position, these two perspectives must be reconciled and one must ensure that the entire organization is working towards the same goal. (Slack & Lewis, 2008). Moreover, it is hard for the customers to specify future needs and also to understand the possibilities and limitations of technology which means that one must look beyond customers' articulated requirements and address latent, hidden needs and furthermore consider generic trends (Clark, & Fujimoto, 1991. Christensen, 1997).

Volvo Car Group (Volvo Cars) was founded is Gothenburg, Sweden in 1927. The founders; Assar Gabrielsson and Gustaf Larson, strived to develop a car under the motto of safety and quality, something that is still very much true for Volvo Car Group today where the core values are safety, quality, design and environment (Volvo Car Corporation, 2014). The corporate and brand strategy is "Designed Around You" where the aim is to put people in focus in everything the company does. Volvo Cars was a division of the Swedish Volvo Group until 1999, when it was bought by Ford Motor Company. Since 2010, Volvo Cars is owned by Zhejiang Geely Holding of China. Volvo Cars is a premium car brand, and a relatively small actor on the global market with sales in about 100 countries.

A new car project has recently been initiated, in the Volvo product portfolio. For this project the product development process has been changed and a comprehensive explorative customer research has been performed early in the project to obtain more data about customers and their needs. In the customer survey 237 participants in five different cities

around the world were interviewed using focus groups and in-home interviews. The most important factor concerning customer research is however not the extensiveness or quality of the research, but more important is to consider how the information attained is used. It is more beneficial to make a small customer survey and ensure that information is analysed thoroughly than the reverse (Kaulio et al., 1999). Based on the extensive research carried out in the current case, it is thus important to examine how the information is coordinated, interpreted and used during the product development phase at Volvo Car Group.

1.2 Purpose

Initially the report aims to (1) identify established requirements based on the performed customer research. Once this has been executed the purpose is to (2) investigate how different requirements are prioritized. Further, the report intends to (3) explore how the requirements are communicated to the organization and (4) how customer requirements are transferred to a technical product specification. Finally, the aim is to (5) investigate whether it is possible to link customer needs to product specification and vice versa.

1.3 Delimitations

Due to limited resources in terms of time and budget, boundaries are necessary. The report has therefore been restricted in scope with the intent to make best possible use of available resources. The project has been limited to only cover the process from set customer requirements to product specification. The report will not treat customer study methods and data gathering, more focus will instead be put on how the data from the performed customer research is used throughout the product development phase.

It is important to emphasize that the report deals with product development in its early phase, consequently the analysis intends to reflect upon the management of requirements and requirement setting in this early phase associated to the initial requirements that are set for the product.

1.4 Research Questions

The foundation for the report is a number of questions which are presented below. The contents are however not limited to these research questions, but the report will also address some areas outside the main area where it is thought to contribute to the understanding.

1) Which requirements have been established based on the performed customer research?
2) How are different customer requirements prioritized?
3) How are the requirements communicated to the organization?
4) How are customer needs transferred into technical requirements?
5) Can customer requirements be linked to the product specification and vice versa?

1.5 Report Outline

The report is divided into seven main chapters.

Introduction: Here the background for the topic, purpose, delimitations and research questions are presented.

Methodology: In this chapter the methodology approach for the thesis is presented, how and during which phase different methods were used.

Theoretical framework: This part presents the theory on which thoughts and discussions in the rest of the report is built on.

Product Development at Volvo Cars: This chapter focuses on how product development project at Volvo Cars are executed. The main focus is the studied care project and the intent is to give an objective description of the process.

Empirical Findings: Based on the interview study this chapter presents project A from a more subjective view.

Analysis: The results from observations and interviews are discussed and analysed. What do these results mean? Are they reasonable? What could be done differently?

Conclusion & Recommendations: In this part the findings in the thesis work are concluded, connected to the research questions and recommendations are presented.

Discussion: In the final part of the report a discussion regarding the thesis, conclusions, and recommendations for future work is presented.

2 Method

In this section the chosen methodology for the thesis is presented. The study's purpose and research questions form the basis for choice of method approach.

2.1 Planning and Information Retrieval

Initially a project plan was created, which aimed to formulate a framework for the progressing work, the time plan can be found in Appendix A. The planning also intended to define the prerequisites for the project and seek the appropriate scope of the report with respect to available resources and time. The thesis study commenced with a pre-study phase where literature studies and observations primarily aimed to create a theoretical framework. This framework worked as a guide for the development of the project and its content. The information retrieval process ambition was to get an indication of available information and previous work within the area. To get a good overview various search engines, catalogues and library sites were used.

2.2 Choice of Methods

The study's purpose and research questions were central in the decision of theoretical framework and methods for data collection and analysis. The report's character is predominantly inductive where the focus was to undertake observations of a specific case and link the findings to theories. Throughout the report a positivist approach is adopted, where a theoretical framework and empirical evidence underlies the analysis (Wallén, 1996).

Based on the research questions the combination of qualitative and quantitative methods was considered best suited for the study. The combination of both qualitative and quantitative are considered to further complement each other well, it gives the possibility to meet the problem from different directions and the combination of different methods increases the reliability and quality of the study (Eriksson & Wiedersheim-Paul, 2008). A qualitative method will be used to study the process, analyse observations and to draw general conclusions based on a specific case (Wallén, 1996). Quantitative methods will be used to more specifically investigate the prioritization and management of requirements.

After the initial phase, the in-depth theoretical investigation started. Throughout the project, observations were performed which form the basis for the empirical investigation. When sufficient knowledge within the field had been acquired interviews were conducted to get a deeper insight into the development phase. Finally, the empirical data from observations and interviews are linked with theory in order to be able to carry out an analysis and to formulate recommendations.

2.3 Data Collection

During the study both primary and secondary data was used. Secondary data was crucial in the initial phase, consisting primarily of information retrieval, while various forms of primary data were deemed important in the later phase. Three main methods were used for collecting data; literary studies, observations and interviews.

2.3.1 Literature Studies

Literature studies within relevant areas forms the basis for the report. The reference frame was created by using tools such as search engines, catalogues, scientific publication databases and recommended literature. This approach was presumed to assure the quality of the reference literature. Furthermore the use of references from previous studies was explored as an approach for mapping appropriate theories and related topics.

2.3.2 Observations

To get an understanding of the product development process at Volvo Cars, a large part of the study was based on observations at the company. Observations in the natural environment gives a proximity to the process which provides a good insight but at the same time this factor can make it hard to keep distance and there is a risk that the observer affects the situation or process he/she is observing (Leijon, 2012). The observations were unstructured, with an exploratory purpose to capture as much information as possible. Compared to structured interviews where the focus has been limited the unstructured technique gives a better possibility to get an overview of the whole picture which at the same time can result in too much information.

Observations gives the possibility to explore what and how certain events takes place during the development phase but does not answer why, which is why the observations were complemented with information from interviews (Leijon, 2012). The idea was to participate in relevant meetings for different purposes with people from all involved departments and to observe how the process works, how the customer needs are prioritized, which decisions that are made and based on what. To get as good overview and insight as possible meetings with different purposes and participants were continuously observed, such as Vehicle program management meetings, Technical concept meetings, Engineering design meetings, Cost Optimization meetings and Styling reference group meetings. At these meetings everything from technical solutions, design, cost, communality, balancing, time, the business case, the product offer, product & process solutions, market offer and positioning, industrial setup and commercial launches was discussed. In addition, observations were also made during an exercise with test-driving of different cars in the proposed segment and by taking part in a three day long cost workshop in the Volvo Hall.

2.3.3 Interviews

In order to obtain additional information on how the requirements are communicated, perceived and transferred into technical requirements interviews was conducted. The intention was to carry out the interviews later on in the project when further knowledge within the area was acquired in order to be inquisitive, able to ask the right questions, follow-up with supplementary questions and to be able interpret the answers (Olsson Jers, 2012a).

The number of interviews was established with respect to the scope of the report and the limited time frame. Furthermore an insufficient number of interviews will make it difficult to draw general conclusions and numerous interviews will make it unmanageable to make thorough analyses and interpretations (Olsson Jers, 2012a). The interviews were performed in person, which is a time consuming technique that at the same time offers more flexibility, gives the possibility to explain and more detailed descriptions (Eriksson & Wiedersheim-Paul, 2008). Furthermore, the personal interview gives a high response rate, it provides the interviewer with control of the situation and the ability to influence the interview and there is no anonymity, which can be both a positive and negative factor (Knutsson, 2008). The aim was to perform around fifteen interviews with key persons from different roles within R&D (Research and Development), Design, PS&VLM (Product Strategy and Vehicle Line Management), MSS (Marketing, Sales and Service), Manufacturing and Purchasing. The selection of interviewees was made with the intent to reflect as great a variety of different roles and disciplines as possible. The hope was that by interviewing people from different respondent groups, which in various ways are involved in the project, capture nuances and diversity around the product definition, requirement specification and product development (Dalen, 2008).

Before the interview process started a framework was created for the interviews in order to give a contextual explanation to the interviewees. The framework provided a background and purpose for the project, who is chosen for interview and why, described how the material was to be used and specified where and when the finished report will be available (Knutsson, 2008). In addition, interview guides were created to ensure that each research question is supported by individual interview questions. In the guides, the research questions were presented thematically in the order they were planned to be addressed during the interview. Before the first interview was conducted the interview template was validated to ensure that the questions were easy to understand and that nothing important had been left out. Furthermore the interview guides were used in order to set a time limit per interview (Olsson Jers, 2012a). The interview guides are presented in Appendix B.

A semi structured interview methodology with open-ended questions was chosen, in order to be able to improvise within the area, asking probing questions and for the interviewees to be able to express a subjective opinion (Olsson Jers, 2012a). To facilitate during the interview the questions were to be kept short and the interviews were recorded to be able

to put full focus on the interviewee (Olsson Jers, 2012b). After each interview the information was transcribed where the audio recording was used as a tool to ensure that no information had been missed.

In total18 interviews each about 45 minutes long were conducted with people from different functions, see Figure 2.1 below.

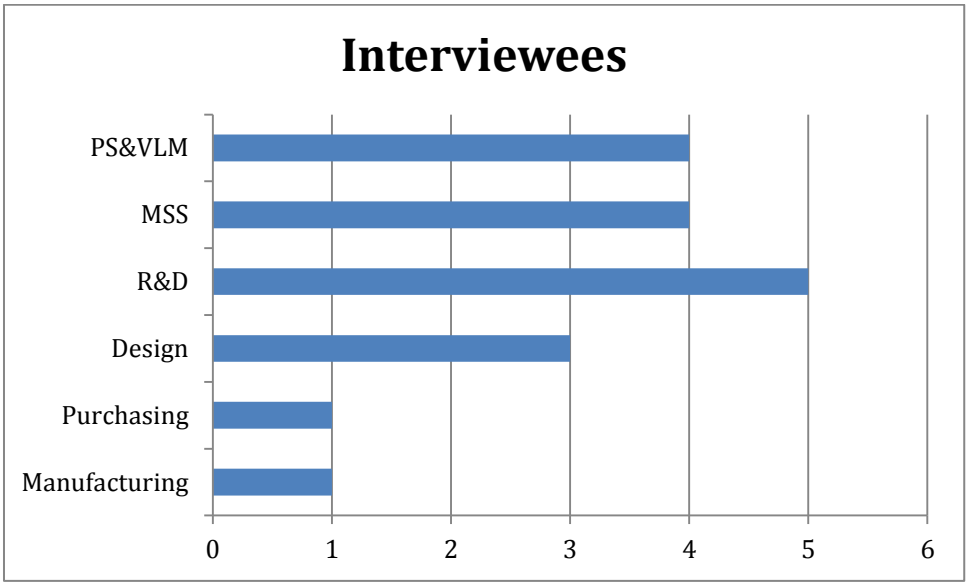

Figure 2.1 Interviewees divided by department

PS&VLM
Senior Product Manager New Cars
Vehicle Program Co-ordinator New Cars
Vice President Product Definition
Product Strategy Manager

MSS
Commercial Line Director
Manager Consumer Insights Central Consultant Team
Manager Consumer Strategy
Model Brand Manager

R&D
Concept Leader Program Engineering
Concept Leader Exterior Engineering
Concept Leader Interior Engineering
Program Manager PKV (Provning Komplett Bil)
Project Leader Exterior Systems

Design
Design Program Manager
Design Manager Interior
Manager Exterior Studio Engineering

Manufacturing
Annual Program Manager

Purchasing
Director Program Purchasing

2.3.4 Analysis of Collected Data

During the project, notes were gathered from observations and the analysis thus began in a relatively early stage and proceeded continuously throughout the project. Observations made at Volvo Cars were linked with theory and generally accepted processes in the area.

To facilitate the analysis process, after the interviews were conducted, the information was first gathered and compressed to get an overall knowledge about the content. The information was gathered in fields with the intent to discern similarities and differences, patterns and relationships in the answers and views of the respondents (Eriksson & Wiedersheim-Paul, 2008). Further calculations were made to show the spread regarding certain data.

Once the vital data was more or less obtained notes were collected in a mind map in order to provide a more holistic view of the project. The collected material was then further analysed by connecting to theory and based on this conclusions and recommendations were conceived.

2.4 Method Validation & Source Evaluation

The literature used as a reference in the report largely consists of books in the field, some of which are used as reference literature in courses at Chalmers University of Technology. Some literature has been chosen after recommendations from professors in the field and articles from various universities have been an important input. Furthermore, doctoral dissertations and their references have been an important part of the theoretical framework. Since the thesis project was limited to a short time period a delimitation of literature had to be made, more references could have contributed to an even deeper and wider approach to the project, which would have been favourable to be able to do an effective analysis. On this basis the literature used is considered reliable sources that reflect the most important features within the area.

Observations were conducted continuously during project, in various meeting forums, to get a deep insight into the working process at Volvo Cars. The observations were of an unstructured following nature to minimize the influence of the observer.

The interviews were carried out a bit into the project when a basic knowledge in the area had been acquired. This enabled the creation of well-conceived interview templates that in a good way captured the main content and research questions of the study. Furthermore, this also meant that a relationship had been created with some of the interviewees, which meant that a trust had been created between the interviewer and the respondent which hopefully allowed the respondents to feel more comfortable in the situation and more willing to share information. There is still however a risk that the interviewees mention things they do not really mean, or that the interpretations of quotes are misunderstood. To minimize risk of misunderstanding and missed information, confirmatory questions were asked and the interviews were transcribed using audio recording in order to truly make sure that the analysis was based on actual statements from the interviewees.

For the interviews carefully selected interviewees from different functions were chosen, however the number of interviews was limited, due to time restrictions for the project, which makes it hard to draw general conclusions. The interviewees were chosen depending on the job role and also in consultation with project stakeholders to create as broad a view as possible. To give a completely reliable results one would have to interview even more people and also people from complementary functions and positions.

To really be able to answer the question: "Can customer requirements be linked to the product specification and vice versa", the thesis project would have to continue for a longer period of time in order for the product to mature and thereby enable the possibility compare customer requirements with the actual product specification. However the project was carried out in the early stage of the development phase which made it hard to make a comparison since too few parameters were determined at the end of the thesis project.

3 Theoretical Framework

In order to answer the report's research questions a theoretical framework has been developed. Chosen theories and models span several disciplines, which all have a role in investigating and explaining the importance of customer needs and requirements within product development. The chapter is divided into two sub-sections; Product Development and Requirements Management.

3.1 Product Development

Companies that successfully introduce new products have a bigger chance of succeeding on today's competitive market. Companies spend billions of dollars on new product development and at the same time 40 to 90 percent (depending on category) of new products fail. One of the reasons is the fact that even though the companies might think that the new product is better, companies do not understand the customers, what they value and the fact that customers make subjective assessments (Burgelman, 2009). Another partition shows that if measured from time of commitment to significant development, success occurs in 11 % of the cases, measured from time of commitment to major development success occurs in 25 % and measured from the time of launch success occurs in 59 % of the cases (Campbell, 2004).

A survey conducted in mid-sized industrial companies in Sweden showed that the two main factors for successful development projects are objective-oriented project management and a thorough requirements specification (Kaulio et al., 1999).

A study performed in 289 new product development projects, that investigated the connection between the working relationship between the marketing department and R&D clearly showed that the success rate is more than quadrupled by a good relationship compared with severe disharmony, see Table 1 (Campbell, 2004).

Table 3-1 Success and failure as a function of the quality of the working relationship between marketing and R&D (Campbell, 2004).

Result	Success	Partial success	Failure
Harmony (41%)	52%	35%	13%
Mild disharmony (21%)	32%	45%	23%
Severe disharmony (39%)	11%	21%	68%

Cars are generally seen as market pull products where the development is based on the market demand and customer's needs are perceived as the essential factor in order to be able to sell products (Almefelt, 2005). Cars are complex products, being built up by thousands of components where the product development is most often carried out in cross functional teams with a division based on sub functions and components. One factor that makes the development of the cars even more complex is the fact that not only requirements matter, but the choice of solution is also based upon personal preferences, power play, emotions and organizational structure et cetera.

3.1.1 Customer Needs

Understanding the customer needs is especially important in the beginning of development projects, when the requirements are set for the product. If the customer needs are not properly understood in the early phase there is a risk that changes have to be made later in the project when it may be difficult to introduce them, and additionally the cost of changes increases the longer the project progresses. Kujala (2002) points out that the source of information for understanding the customer needs is highly important where a direct link to the customer and user is beneficial, and especially understanding the user can lead to a reduced number of iterations in the development process. On the contrary, Steve Jobs, the founder of Apple, said that he did not believe in customer surveys since the customers do not really know what they want until they see it (Kearney, 2013). Jobs probably succeeded with not listening to the customers since he was designing products for himself. If you have the same wants and need as the customers this might be a successful plan, but for the 90 % of businesses that develop products for other customers than themselves it is daring to assume that you know what the customers want.

It is however difficult to work with customer needs and requirements early in the process and this depends largely on the fact that customers' preferences change over time , that customers do not have the knowledge to specify what they want in the future and that different customers prioritize different factors (Kaulio et al., 1999). Or as Henry Ford once said (Andersen, 2013):

"If I had asked people what they wanted, they would have said faster horses."

Furthermore, the early stages in product development are often fuzzy and lack structure, it is difficult to specify requirements early as the understanding of the product grows with time (Kaulio et al., 1999). It is also difficult to transfer the understanding of the customers needs through a set of requirements. Furthermore there are often barriers between different departments, especially between the marketing and development side. To address these obstacles during the development process, it is important to work effectively with customer requirements management and create a standardized process that works well within the company.

In this report the following definitions will be made according to Kujala (2002):

“User need: refer to problems that hinder users in achieving their goals, or opportunities to improve the likelihood of users’ achieving their goals. An important factor affecting o user needs is the context of use. “

“User requirement: any function, constraint or other property that is required in order to satisfy user needs. User requirements are elicited from users and described from the user and customer point of view. “

A user is defined as: “One who consumes or employs a good or service to obtain a benefit or to solve a problem, and who may or may not be the purchaser of the item”. A customer is defined as: “A party that receives or consumes products and has the ability to choose between different products and suppliers” (Business Dictionary, 2014). In this report the assumption is made that the customer and user in most cases is the same party and therefore the term customer will most often be used.

A success factor as mentioned earlier, is the importance of collecting information about customers early in the development process when there is great potential to affect the product content. However, the need for immediate information and feedback from customers should not end there but is of great importance throughout the product development process to validate and verify the result(Kujala, 2008).

3.1.2 Customer Requirements

As previously mentioned it is essential to focus on the customer needs and requirements already from the beginning in the development project, otherwise there is a risk that: the product may not satisfy the customer needs, multiple interpretations of requirements may result in disagreement, not possible to test if the product meets the customer needs and resources in terms of both money and time might be wasted on developing the wrong product. (Kujala, 2002) This means that requirements management usually requires that a lot of resources are spent early in the product phase but on the other hand the workload is then decreased in the later stages (Almefelt, 2005). Furthermore, provided that the requirements are based on an advancement and future products, requirements management may also be a way for companies to focus on innovation.

In a case study performed at Volvo Car Group it was found that the requirements specification, concept proposals and evaluation matrices were considered the most useful information in the project. In a 12 year study performed in Germany the researchers concluded that requirements management reduced needed resources in form of time and cost since the specification facilitated the process, provided available information and a target for evaluation of solutions (Almefelt, 2005). A perfect requirement specification does

evidently not mean a perfect product; motivation, passion and communication are vital factors that play a big role in the project success or failure.

3.2 Requirements Management

When talking about requirements and product development two terms are usually used; requirements engineering and requirements management. According to Kujala (2002) requirements engineering "covers all of the activities involved in discovering, documenting and maintaining a set of requirements for a system". Requirements management is generally described as the process of defining, prioritizing, changing, balancing and verifying the requirements during the development process, which is a complex practice (Almefelt, 2005).

3.2.1 The Requirements Process

The most important according to Kaulio et al. (1999) regarding the process is that the focus should be on customers and how to create value for them. The process must be clearly defined, described in terms that fit different projects, and documented, this also allows the process to be repeatable. Furthermore, it is important that there is someone in charge of the process and to follow up the results. Customer requirements management may for example be measured by customer interaction, lead-time, man-hours and other costs in relation to performance in terms of market share, late changes and satisfied customers.

There are several processes suggested by different authors within the area of requirements engineering and management. Virtually all requirements processes can be said to consist of a certain number of steps which can briefly be summarized with the help of the four stages that Kujala (1999) proposes. The requirements process can be divided into four different subtasks; requirements elicitation, requirements analysis and negotiation, requirements documentation and requirements validation. Requirements elicitation is the process of discovering, collecting and understanding customer needs. As the elicitation process comes to an end the requirements analysis and negotiation process begins. During this process the requirements are discussed and the project stakeholders agree upon the definition of requirements. The next step is then to document the requirements in a structured and easy understandable way. Finally, the requirements must be validated against the customer needs to be able to detect errors in the requirements documentation before it is used in the development (Kujala, 2002).

Kaluio et al. (1999) describe a quite similar process for handling customer demands where the focus is to build an understanding of the customer to create a product which the customer wants. The process is not sequential but can be carried out in parallel, all to adapt to each company and its situation. The process involves the following steps:

- Selection: From the target group one most carefully select participants for the research.
- Collect: The next step is to collect information from customers.
- Analyse: The gathered information is analysed and an understanding of the customer is created.
- Generating concept: Generating concepts and trying to solve the problem is something that takes place gradually throughout the process.
- Formulate customer requirements: From a customer understanding one creates customer requirements and arrange these in a structured way. In addition, complementary requirements for the product (profitability requirements, legal requirements, et cetera) are added to the list.
- Prioritizing customer requirements: To emphasize the important areas and facilitate the selection of the concept, the requirements are prioritized.
- Choose concept: Using the list of customer requirements and the prioritization one can choose between different concepts to finally find the solution that meets the product requirements in the best way.
- Verify: The concepts must be verified throughout the development against the list of requirements to ensure that all requirements are met.
- Validate: It is important to validate the requirements to ensure that the demands truly reflect customer needs. The validation can be done in several stages during the process, for example by allowing customers to validate the requirements list or validate various concepts.

Further on Ulrich and Eppinger (2012) recommend a five step process for defining customer needs:

1. Gather raw data from customers
2. Interpret the raw data in terms of customer needs
3. Organise the needs into a hierarchy of primary, secondary and tertiary needs.
4. Establish the relative importance of needs.
5. Reflect on the result and the process.

As a summary one can state that important aspects of the requirements specification is gathering data about the customers, analysing the data and stating requirements, organising and prioritising requirements and finally validating and verifying the requirements.

3.2.2 Manning

In terms of staffing, there are a number of important factors for the development project to be successful. It is essential that the project team is staffed by a multidisciplinary team, that there is a strong ability to manage projects as well as that representatives from both the marketing side as well as from the development side take part in the customer research (Kaulio et al., 1999). Developers interacting with customers increase the understanding of the users' needs and values and on top of this the interaction gives a great chance to capture the true customer needs where problems sometimes can arise when developers who are

themselves users of the product expect ordinary users to have similar needs and values as they have (Kujala, 2008).

Additionally, cross functionality is a significant success factor where working with a cross-functional team in the early stages of the requirements specification process facilitates the collaborative work (Almefelt, 2005). Further on focus on cross-requirements follow up can provide many benefits in an opportunity to focus on how to fulfil several requirements with a solution.

Furthermore, it is important to focus the company's total resources on a limited number of projects to ensure that resources are available from all the different needed functions (Kaulio et al., 1999). For the people involved in the project team, it is advantageous if they work at least 50 % of their time on the project. This facilitates the development process and the communication and allows each project to proceed faster. In order to create an effective team with good project knowledge, it is also important to create an early involvement in the project.

3.2.3 The Requirements Specification

The requirements specification has two important purposes; first the specification shall serve as a guide during the development of what should be achieved and in addition the specification shall be used to measure outcomes and making evaluations. The requirements specification should contain all necessary requirements from different stakeholders involved in the development process such as marketing, customers, manufacturing, R&D, design, corporate strategy et cetera (Almefelt, 2005). The quality of the requirements is of course an essential factor where the development work is more successful generating higher customer satisfaction if the requirements are based on real information collected from users (Kujala, 2008).

Regarding the formulation of requirements, it is of course important that it is the correct requirements that are formulated based on product needs (Shefelbine, 2002). Furthermore, it is also important that the requirements specification is:

- Solution independent – the requirements should specify *what* is needed, but not *how* it should be done.
- Complete – the specification must include all involved areas.
- Clear – the specification should be distinctly defined to complicate misconceptions.
- Concise – only necessary information should be included in the specification.
- Quantified – it should somehow be possible to measure if the requirements are met or not, for example by quantitative limits or ranges.
- Traceable – it should be possible to trace the requirement from the origin to its implementation in the design.

Moreover Hull et al. (2005) points out that the requirements should be:

- Atomic: each statement carries a single traceable element.
- Unique: each statement can be uniquely identified.
- Feasible: technically possible within cost and schedule.
- Legal: legally possible.

According Kaulio et al. (1999) there are four important aspects of the requirement specification: 1. The specification shall determine what is desirable/undesirable for the product. 2. It shall specify the methods that can be used to probe if requirements are met or not. 3. It must specify a level where the requirements have been met. 4. The specification shall specify how the requirements are to be prioritized.

A well composed requirements specification can also provide the possibility to reuse requirements where they do not change for other products, which can provide benefits in form of time savings and standardization of structures and solutions (Almefelt, 2005). However, one must always be careful when reusing requirements and evaluating the requirements for each product case, otherwise there is a risk that the product might fail. One example of a failure in requirements reuse is the case with the Tacoma Narrows Bridge where the requirements were reused not taking into account the different conditions, which lead to a collapse of the bridge.

3.2.4 Prioritization

Focusing on fulfilling all requirements in the specification most often leads to sub-optimization since the requirements are often conflicting, therefore a flexible approach is needed to obtain the best overall result (Almefelt, 2005). There are most often numerous customer needs, too many for one product to satisfy and thus the identified customer needs ought to be categorised and prioritized, where a structured presentation of the requirements is a useful tool (Kujala, 2008).

In his doctoral thesis Almefelt (2005) proposes a few recommendations for requirements management:

- Clarify individual requirements and the context and underlying intent, define interfaces, and specify verification method and priorities.
- Establish requirements early but be open-minded to changes.
- Emphasize a set of key issues, in order to create a shared representation during the development process.
- Develop a cross-system specification providing a summary of the most important requirements.

Almefelt (2005) means that the difficulty often not lies in setting the requirements specifications but in managing the requirements during the project time and ensure that

they are met. Furthermore, it turns out that in many cases requirements are prioritized in different ways compared to the specifications during the project, where resources within different areas, work procedures and project focus are important. Requirements that are not actively promoted during the project run a risk of being overtaken. Requirements that are taken into consideration during the early stages are much more likely to be fulfilled than requirements that come later.

Prioritization of requirements also fulfils another significant function as it is central to clearly point out the most important requirements as humans only have the capacity to remember 7±2 information units simultaneously. A wordy requirements specification is not possible for the developers to keep in mind during the process and therefore it is important to identify the key drivers for the product. Davies (2004) suggests identifying the "Top Ten Key User Requirements" and these top ten requirements should also be prioritized among themselves. If the developers can keep these top ten requirements in mind, they can more easily visualise possibilities and issues in order to try to find the optimum system.

In some cases, one may already in the collection of customer data, get a good picture of what requirements must be prioritized and how, but in other cases it may not be so obvious. In that case you might have to make further data collection to let the customers be involved and prioritize requirements (Kaulio et al., 1999).

3.2.5 Balancing

Studies show that even though companies focus on requirements management, improvements can in many cases be made regarding the balancing of requirements (Almefelt, 2005). There is a risk that decisions are taken in individual forums where consideration of the overall business case, product and requirements are missing. With this in mind, it is therefore important to always focus on interdisciplinary requirement analysis and to make decisions with the overall product solution into account.

One of the most important tasks within requirements management is balancing, which involves balancing different product demands, properties, performance and cost against each other in order to produce a successful product (Almefelt, 2005).

3.2.6 Communication

A successful customer research and gathering of information about customers and their needs does not however immediately mean product development success (Kujala, 2008). Customers know what they want to achieve with the product but it can be hard for the customers to communicate what they need and also understand what is technically possible and not. A key factor in the process is to be able to analyse the material and gather the information to easy understandable product requirements.

It is important that the list of requirements not just becomes something that is created in the beginning of the project and then is forgotten. A specification is usually not enough but there is a need for other mediating tools such as characters, different descriptions or scenarios, sketches, prototypes, et cetera in order to communicate an image of the customer and his needs (Kaulio et al., 1999).

Additionally one must understand that customers and developers have different interests, considerations and vocabularies which can make the communication complicated (Kujala, 2008). Customer needs must be presented in a way so that it becomes easy for developers to use the information during the process. For the reason that both values and language can differ greatly between customers and developers, it is important that developers who have taken part in the customer survey also takes part in the process of analysing the material and transcribing customer needs to customer requirements.

An example studied by Smith and Smith (2012) clearly shows the difference in the language use between customers and developers where customers used wordings as “exciting”, “easy to use”, and “prestigious” and developers used words like “‘type”, “screen shape” and “function keys” to describe mobile phones. The developers therefore need to take an active part in understanding the customers and their needs. Kujala (2002) also found that in some cases it was hard for the technically oriented designers to use the customer needs in the product development, that is to transfer the needs into product requirements. In order for the designers to more clearly understand the customer needs it is therefore important to consider how the needs and requirements are communicated within the development team.

In many cases the information is overwhelming, written in long descriptions which makes it hard for developers to handle. Kujala (2008) therefore suggests transcribing the requirements in a more formal way, for example by using user-need tables where user problems and possibilities are presented. In studies conducted by Kujala (2002) user needs tables were introduced as a way to represent the results. The user needs tables facilitated for designers when transforming user needs to user requirements. Presenting the information in a structured way is beneficial throughout the development process and it may also be advantageous to use different types of descriptions during the process phases.

Additionally one must also consider the fact that the interests and vocabularies also differ a lot between different functions within the development team which can complicate the communication among the cross functional members. As a way of overcoming these communications issues Leonard-Barton (1991) proposes using models and prototypes as inanimate integrators. The benefit with using physical models and prototypes compared to specifications and sketches is the possibility to touch upon several senses – sight, touch, hearing and possibly taste. The communication thereby moves from the specialised language used by experts to a more mutual language and also helps in creating a unified development team. Models can also be of benefit in order to uncover gaps in the concept,

learn more about the user needs, understanding the problem and have a potential to accelerate the progress by forcing structuring of previously unstructured knowledge. A successful example of a well-used model applied in the early phase of the development process of the Sony Walkman. In order to demonstrate to the development team what they wanted to accomplish, the lead-engineer brought a small block of wood in order to visualize the new product. The block of woods seemed incredibly small compared to the existing solutions, but in the end the engineers succeeded in delivering a product as small and simple as the model symbolised, a lot thanks to the common view that the block of wood created.

Kujala (2002) also mentions the fact that to clarify the needs it is in most cases beneficial to use several ways of communicating and showing the requirements. In addition to a customer needs table, user profiles, photographs and other mediating tools can be used to visualize what is desired from the product. An example showing the importance and influence created by the use of different mediating tools was given in an investigation of a ticket system for a Swedish public transport provider[1]. The investigator tried to show the problems and dissatisfaction that the users experienced when using the ticket system, but the management did not seem to fully grasp the practical consequences the system had for its users. After some time the investigator finally showed a short video demonstrating passengers trying to use the ticket system. The video seemed to make a huge impression on the management, displaying the users' problems, and the readiness for action was increased immediately. The proximity to the users that the video provided gave an advantageous understanding of the users and their needs which made the managers realise the problem and also gave an opportunity for the developers to understand the problem and further improve the product[2].

3.2.7 Validation & Verification

In order to succeed with the requirements management it is important that key issues are well rooted in the management and that the requirements and the fulfilment are continuously monitored (Almefelt, 2005).

Once the requirements are specified it is also important that they are validated and verified (Shefelbine, 2002). Validation of the requirements means confirming them against the product needs, in other words answering the question: *Are we building the right thing?* Verification of the requirements is done to ensure that the output in the development process meets the specified requirements and answering the question: *Are we building the thing right?*

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[1] Pontus Wallgren, Assistant Professor Design & Human Factors, Chalmers University of Technology. Interviewed by the author, 18th of February 2014.
[2] Oskar Rexfelt, Assistant Professor Design & Human Factors, Chalmers University of Technology. Interviewed by the author, 8th of May 2014.

When talking about requirements management one important subject is requirements traceability which concerns how requirements are transformed into product specification and solutions (Almefelt, 2005). Quantitative traceability concerns understanding how much a change of a requirement changes the solution and vice versa. Qualitative traceability means that there exists a link between a specific requirement and a certain part.

3.2.8 Methods

The requirements specification and management has become more and more complex within the car industry as companies build multi-brand organisations and platforms (Almefelt, 2005). Furthermore there is a trend to allocate some of the development to suppliers which places even greater demands on the requirement specification. Despite the nature of cars and the product's high complexity, there are few specific techniques used in industry to manage this complex development process, something that has been pointed out several times by academic researchers. Meanwhile, most of what is written on the subject is of a descriptive nature and few attempts have been made to capture and analyse the different methods used and their effectiveness.

Requirements management demands structured procedures in order to succeed, something that in most cases support the development process but there is also a risk that it might result in over complex work procedures. The general opinion is however considered to be that focus on the requirements is essential for the development of successful products and that structure provides a good way of concentrating on the right issues. Product development methods have shown to be effective during the development process, especially by providing a common view of the process and improving communication between cross-functions. Almefelt (2005) points out that it is however difficult to prove that a particular method gives better results than others since product development is such a complex process.

There is however a general movement in the direction of a more structured process but many companies still seem unaware of the potential advantages that could be obtained from introducing product development methods. One common concern is that the product development method will absorb more resources than it will generate in value. Other drawbacks that are often mentioned is that many methods assume that all relevant information is available already in the early stage of the process and can be described in a clear specification and that the methods slow down innovation. This may partly be a problem, but does not need to be depending on how the requirements management is handled during the project. There is however a big risk that the requirements change over time. Three main reasons for that requirements change are technological evolution, competitors and customers. According to Almefelt (2005) a common problem during the product development process of cars is that companies have a hard time to deal with requirements and prerequisites that change over time. Therefore, companies often choose

one solution in the early stages, hoping that it is correct, which makes it difficult to make changes at a later stage. Another option is to wait with deciding a solution to a later stage when all conditions are available, which in turn makes the decision based more on facts and means that the risk of late changes becomes smaller. This method is called set-based engineering and is successfully used by Toyota.

There are several different methods that can be used during the transformation of customer requirements. There is no universal method that fits all businesses and in all situations, but the important thing is to find something that fits the specific case depending on the project, time, resources and experience. In the absence of methods for handling customer demands, it is important to begin somewhere (Kaulio et al., 1999). The greatest impact can be achieved by starting to handle customer requirements in a structured way. The best solution is to use several different methods during the process since the methods can complement each other with their respective strengths and weaknesses. Two important aspects in this matter is that it is important to make sure to meet the customers by yourselves and to keep in mind that the customer may not be able to tell you what product they want.

There are several different methods that can be used when prioritizing requirements. Two of the most common and effective methods are presented below (Kaulio et al., 1999).

- Pairwise comparisons: Involves letting the customers prioritize between different requirements in a list and through a systematic comparison one gets a hierarchy of requirements.
- 1000 note: In this method involves the customers to allocate 1000 SEK on a number of requirements, the customer must allocate all the money and all requirements must get at least 1 SEK. The advantage of this method is that it not only provides a ranking but also gives a picture of the requirements relative importance to each other.

When it comes to the balancing process, one commonly used method is the Pugh matrix. However Pugh and other methods like Kesselring matrix generally involves a consideration and evaluation of several concepts, a disadvantage with these methods is that it is difficult to analyse the interrelationships between requirements (Almefelt, 2005). Quality Functions Deployment (QFD) is a method with the purpose of translating internal and external needs into product specifications. QFD can be used to prioritize requirements, find correlations, evaluate solutions and compare the concept with competitors (Valtasaari, 2000).

4 Product Development at Volvo Cars

Product development of automobiles, are large, complex projects with numerous people involved. This chapter intends to initially provide a background picture of the development process at Volvo Cars and provide a context to the studied project A and the present state. Next the project A is presented, the customer research, requirements and process. The material is mainly based on observations and for the study conducted interviews, and as a complementary source Volvo's Business Management System has been used.

4.1 The Development Process

At Volvo Car Group, one uses an overall Business Management System (BMS) that describes how the business is managed and conducted. BMS is based on the company philosophy which is the overall platform of the business and operations. BMS also consists of organization structure, operations, authorization rules, decision-making forums and other conditions that describe how the operations are to be conducted.

At Volvo Cars the product development follows a system called the Volvo Product Development System (VPDS). VPDS contains a product development plan with definitions of project deliveries, and describes how to integrate parts and synchronize processes in projects and is a method used in order to standardise the process. In VPDS the development process is divided into four phases; strategy, concept, industrialisation and maintenance phase, see Figure 4.1. For each of these phases, there are a number of milestones and gateways for all involved business levels and departments, which defines what should be achieved by when, what decisions that should be taken and what maturity that is needed during the process. Depending on the art of the different milestones and gateways an approval is required from different authorities sometimes up to board level in order to proceed to the next step, which is also clarified through VPDS. VPDS contains three main cornerstones:

1. Integration: Integrate all pieces into a product that meets the business requirements.
2. Compatibility before completion: Get the big picture right before starting with details.
3. Delivery precision: Deliver on time with right quality. Describes when activities should be completed.

The product development work is conducted in cross functional teams, where many of the involved employees work on several projects at the same time. For the project a Vehicle Program Management group is uppermost responsible and this group meets once a week in order to go through the project, present and discuss various business and product decisions. For the product, there is also a product manager who is responsible for prioritizing and executing strategies, to ensure that future product actions are in line with customer wants

and needs and to ensure a competitive and profitable car whilst simultaneously enhancing the Volvo brand.

Furthermore, there are also instructions for which material regarding the product and the specification that should be provided, in what format and where it will be available in order for all interested to know where to find the information. During the development process Team Center is used, which is a system used for storing and structuring design models for instance used for virtual design, calculation and requirements.

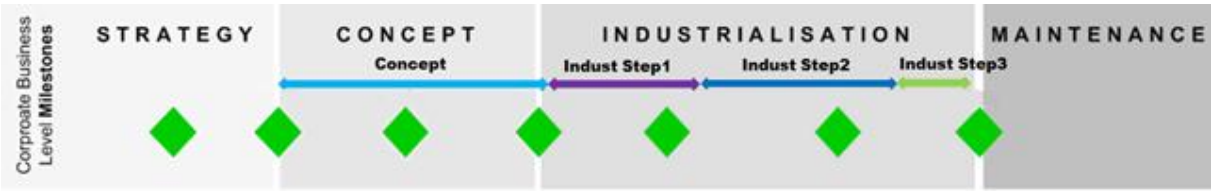

Figure 4.1 Corporate Business Level Milestones. The development is divided into four phases where the green squares represent different milestones at the corporate business level.

4.2 Product A

The product A is a new car project that was initialized in 2012, see Figure 4.2. At the end of 2012 product A was approved at the business milestone gate Product Strategy Intent (PSI) and the strategy phase was thereby started. The main focus during the strategy phase is project definition. In the beginning of March 2014 product A passed the final gate in the strategy phase; Product Strategy Finalised (PSF) and is now currently in the concept phase where the main focus is to further define the design. In the autumn 2014 the product A will reach the milestones Program Start (PS) where the intent is to start the program with set prerequisites, mission, targets and program finance. Car A is built on a newly developed platform which is shared with other cars that are in a later state in the development phase. This means that the platform is already locked in some respects, and this might thus limit the design of product A in some aspects.

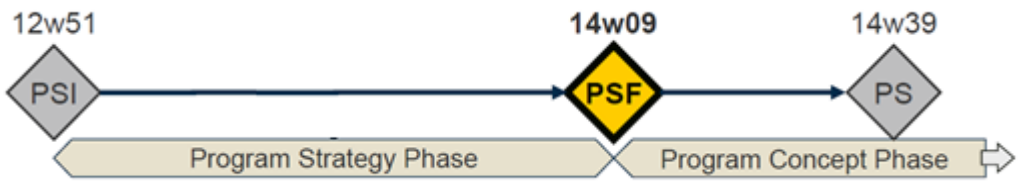

Figure 4.2 Timeplan product A.

4.2.1 Customer Needs & Requirements

In order to identify a product definition for project A an explorative customer research was performed. The research was conducted during the autumn 2013, from week 40 to week 45. The research locations were Los Angeles, Hamburg, London, Beijing and Ningbo, based on market share and also the fact that the aim was to get an understanding of the global market/customer and look at nuances at the different locations, see Figure 4.3.

Figure 4.3 Research Locations

At the customer surveys four to eight Volvo employees attended on each research site. The Volvo employees had different backgrounds and came from the departments where the intent was to create a cross functional team with a broad knowledge base. People from PS&VLM, MSS, VPMM and R&D were a part of this cross functional team. 237 persons participated in the survey, the interviews were conducted both in focus groups (80 hours) and in-home interviews (180 hours). Since the project A is a brand new product in the Volvo product portfolio the decision was to interview both people who currently own a Volvo and people who own a car in the intended segment from a competing brand.

After the research was conducted a workshop was organized where most of the Volvo employees who had participated in the customer research were gathered and additionally also employees who had not taken part in the customer research. At the workshop the outcome of the study and the results from the different research locations was discussed and concluded. As a part of the product definition process the core team drove competing cars to get a perception of the different products and understand the customers' comments. Based upon the performed research a research report and a Product Definition was generated and finalised in December 2013. In the end of January 2014 the product definition material for product A was approved by the Management Team at Volvo Cars. Once the product definition was accepted the Product Definition team presented the material at

meetings connected to the project, and in addition there was an opportunity for Volvo employees to reserve a spot on a few different sessions where the material for Product Definition A was presented.

4.2.2 Product Definition

Based on the performed customer research a Product Definition was created for product A. Below the requirements that have been stated in the Product Definition and in the Product Guide for product A are presented.

- Trendsetter/Expressive/Youthful/Masculine design

This includes a polarizing design that results in either strong acceptance or rejection. The car should have a powerful front with high tech head lights and exterior colours that enable to stand out. The design shape should be chunky and not boxy or round.

- Command seating

The car should offer a clearly higher in command seating position than competition, higher seating from floor and higher eye position over road. One should not focus on rear visibility, front down visibility, and side down visibility.

- Clever use of space for My stuff
  - Front Row: To be the choice of the customer Volvo must offer superior space for my stuff in the front row. This includes smart stowage in doors and accessible and usable stowage. Requirements are: cup holders, dedicated place for smartphone, a solution for USB cable and inductive charging for smartphone.
  - Trunk: To be the choice of the customer Volvo must offer superior usage of space for my stuff in the trunk. It should be really easy to fold seats and open/close the trunk. The car should have a flat floor from bumper and flat floor when the seats are folded. There should be solutions for securing and arranging load. One should not focus low load level from ground. Requirements are: reclinable rear seat for trunk space, usable ski hatch, 12 V in trunk, power operated tailgate as option early in the trim levels, fit a stroller, a golf bag and a bike when folded seats.

- Me Car: Priority should be placed on ”me”, the driver, and ”my stuff”.

This means that car content, shifters, handbrakes et cetera should be minimized.

- Everything Car

The car should offer competitive cargo space; TBD litres with rear seat up and TBD litres with rear set folded - with a flat surface.

- Responsive Drive

The car responds directly to the driver actions. Agile dynamics-responsive pedals and steering; focus agile dynamics and performance at city traffic speeds. Easy maneuverability at low speeds, that is when parking

- Volvo Safety Leadership

The car should get top result in selected objective safety ratings and leadership within Collision Avoidance

- Competitive Co2 with BIC OFFER

- Volvo smart solution for everyday life

"Clever use of space for My stuff"

4.2.3 Communication

The Product Definition was presented to the involved staff through a presentation given by the product definition group. The presentation consists of a 100 page long PowerPoint document which describes: product definition, product definition process , volume, pricing, total cost of ownership, competitive context, market, target customer, customer centric product definition, product attribute profile, accessory and the next step in the product definition process. The final Product Definition was presented and approved at PS&VLM, PMM and EMT week 5 2014. After that the material was further presented by the Product Definition Team to different forums within the company. In addition, all employees at the R & D department had the opportunity to reserve a spot on any of eight presentation occasions in the Volvo Hall. These presentations had booked through the LAD, which is a learning administration system where activities such as teacher-led and web-based courses, seminars, and workshops can be booked by Volvo Car employees.

Product Guide is a PowerPoint document of about 60 pages which contains a description of the product in terms of Role in Brand Portfolio, Competitors, Product Definition, Main Dimensions, Total Cost of Ownership and Product Attribute Profile. Product Guide is an extract with the most important information from the Product Definition. There will be three versions of the Product Guide, one released at a final gate in the strategy phase, one version released in the middle of the strategy phase and a last version released at the end of the concept phase. The idea is that the Product Guide will be made more and more detailed further into the development process. All changes between the different versions of the Product Guide are recorded in a change log.

5 Empirical Results

A number of interviews were conducted to create raw data and strengthen the report's credibility. This chapter is essentially based on the results of these interviews, and it presents the project group's view of project A.

5.1 Customer Needs & Requirements

Everyone who took part in the customer survey seems to agree that this time it has worked very well with customer research and the cooperation with the agency Northstar. One comment that emerges is that most people think that the explorative customer research and the Product Definition came a bit late in the process. This is something that has been noticed and the plan is to try to change the timing of the product definition for future projects.

Almost everyone who took part also seems to think that it worked well with the workshop that was held at home in Gothenburg where all the information was collected. A slight criticism concerns the fact that all who had participated in the customer survey did not participate in the workshop, and also that some project members who had not participated in the surveys was a part in the workshop. All seem to think that it worked well with the team in the workshop. It was an open environment in which everyone was allowed to speak and was respected.

Furthermore, all seem to agree that what was decided during the workshop was of high quality. The team came to an understanding and ultimately agreed upon an outcome that everyone supported. However, there is some concern about the fact that even if everyone agreed in the workshop, there is a risk that when everyone progresses to respective department they take with them what they thought was important rather than the material that was decided important in the workshop. It has also been found that during the product definition time the research material was cleaned from information and customer needs that were no longer accomplishable since the product gets more and more restricted as the development of the platform proceeds.

In conclusion one could say that within project A one is very pleased with the performed customer survey, from the extensive research a lot of valuable information was gathered which has been reduced to a Product Definition that the core team has agreed upon. There is also a confidence that the data from customer surveys are used in the product development, which the comment below clearly shows:

- "I feel that information about clients is used more now than 10 years ago, before it felt more like something that one more or less ticked off in a box. Now it's more active choices, trying to achieve what the customers want, this is also connected to the corporate and brand strategy *Designed around you*."

5.2 The Requirements Process

At Volvo the VPDS and BMS systems provide guidelines for how the product development process should be performed. Despite this one notices that it is not evident how the process should be performed, what should be done by when and who is responsible for what. One reason for the uncertainty about the process might depend on the fact that many of the concepts leaders in this case are inexperienced and not accustomed to working in the concept phase.

Comments made during interviews show that:

- "It is a little unclear what to do when and which milestones that are set for project A. It would be a good idea to perform a workshop at the beginning of the project, where all parties are gathered in order to go through the process, so that everyone gets an overview of what should be done, when and how all parts are combined."
- "More control of the project is needed, there must be someone who is clearly responsible for the product and the big picture, all major decisions should be taken by this person, and then this person must have some under him to take care of other issues."

Besides a more clear structure and governance of projects suggestions were also made on how to improve the process in order to achieve the Product Definition:

- "Something that could facilitate the process is if the Product Definition could be decoupled from the project so that one could have the opportunity to begin examining different ideas already before the project start. Now the customer need is presented at the beginning of the project, which might make it hard to reach the requirements since no preparatory research has been done."

5.3 Manning

A cross-functional team with members from MSS, R&D and PS&VLM was created for explorative customer research. A few people from VMCC (Volvo Monitoring and Concept Center) also participated in a few focus-groups interviews. Most believe that the design department was lacking in the cross functional team, a few suggest that it would also have been beneficial to include more employees from the R & D department. Someone pointed out that it would also be advantageous to include people from purchasing during the research and that the knowledge from employees working at sales companies in various markets during the investigations would be useful.

When questioning if: "Do you have any suggestions on how to improve the data gathering process?" at the interviews, the following answers were articulated:

- "It would have been useful to have someone from the design department participating in the research so that one had been able to capture the most important things. 2-colours were nothing that the customers mentioned that they wanted and there is nothing that says that the customer wants 2-colours and is willing to pay more for it. It is difficult to distinguish between what is my own opinion and what is the big picture if you have not taken part in the research and the workshop that followed."
- "The advantage is that the purchase department has the entire supply chain behind them and can help with a lot of knowledge even in the early phases; come up with alternatives, present benchmarks and where competitors are on the way."

5.4 The Product Definition

On the whole, one can say that there are two different opinions about the Product Definition. Some think it is clear, valuable and gives a good insight into what product one will develop in project A while others feel that the information is too vague and gives an unclear picture of what product you want to achieve. The reviews also seem to be closely associated with the department or position of the interviewees where one can generally say that those who are involved in product definition work are satisfied with the definition while those working more with the product development of product A think the information is vague, see Figure 5.1

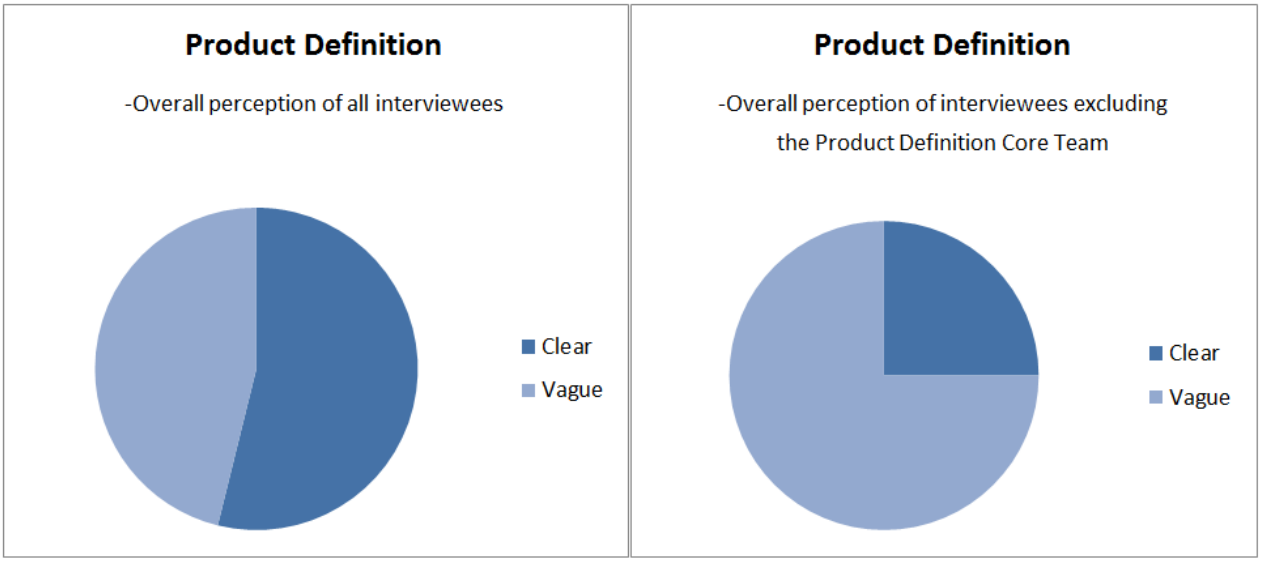

Figure 5.1 The perception of the Product Definition. The chart to the left shows the overall perception of all interviewees. The chart to the right shows the perception of the Product Definition excluding the interviewees that are a part of the Product Definition team.

The comments below are answers to the question “Do you think that the Product Definition and the requirements that are stated are clear?”

- “The information is vague and did not give concrete instructions for how the car should be designed and what to invest in. It gives more of a glimpse of what kind of product one wants to create but rather vague information to make decisions.”
- “I do not feel that the requirements are clear, the material is too fluffy for engineers to know what to do, so that one does not always do so as they usually do. You cannot do everything everywhere.”
- “Do not feel that the Product Definition is clear. I understand what they want to achieve but I do not think I have a clear product image, it is too vague. The product should be inexpensive, practical, modular and premium, then you get an unclear mix of everything and that will not work. You have to choose one focus and then you have to think about what the brand focus is (premium) and how to support this. “
- The Product Definition is too broad, contains things that I as a developer/designer am not at all interested in and there is no sharp message.
- “The product definition material for product A is the best I have seen here. For our department the material in the Product Definition and Product Guide is good enough to know what they need to focus on.”
- “The Product Definition is clearer than ever, this provides great opportunities. The presentation itself is not as clear as needed, you need to see what the Product Definition Team prioritizes and get explanations to fully understand. The information is too vague in the Product Definition, it is probably just the core team that has a good idea on what you want to achieve. Perhaps one needs to clarify; we want the same height as this competitor et cetera. Maybe a good idea to make a list of the important requirements. In the CV spec you can find more information and dimensions but perhaps only a few people have seen it.”
- “Easy to understand the Product Definition, it is easy to understand for myself what it means for my areas. Do not want clearer information, since if the Product Definition and requirements are too clear then there is no freedom and therefore a risk that the product will be locked with a non-optimal solution.”

Talking with employees from the Product Definition Team they are aware of the fact that the information in the Product Definition and product guide is vague but they mean that it is up to respective R&D or Design department to ask questions and have a discussion with the Product Definition Team in cases when they are unsure about the definition or how to prioritise. One member in the Product Definition Teams explains:

- “The idea is that you should check the Product Definition and what to do/what not to do and have a discussion with the Product Definition Team if anything is unclear.”

When asked which are the three most important requirements in the Product Definition, all basically answer the same things. Evidently the message about what is important for the car in general has been perceived, but if you then discuss further what these three requirements mean more in detail, it is unclear and difficult to identify more concretely what to focus on.

Requirements are in many cases set in relation to competitors, for example: product A needs to be higher than this car. Volvo compare characteristics of competitors and sets goals in relation to them, checking what the competition has not done good enough and then Volvo tries to make an improved product compared to the competitors.

5.5 Prioritization

Another problem raised by the development team is that you do not know how to prioritize different things. The Product Definition explains what you want to achieve, but not how to prioritize things if you have to choose between the various features mentioned in the definition. The perceptions of the prioritization of needs are presented in Figure 5.2. In the Product Definition, there is some will/will not and this is something that everyone agrees is very good and gives clear information about what to focus on but more of this kind of information is needed. An example of a priority question is whether what is most important regarding the front doors; to invest in a lot of storage by removing the speaker from this part, or if Me-car means that it is important to have good sound, and if the speaker therefore should be given priority over storage. In this issue the Product Definition Team declares that storage is important, and that sound is important as well, which means that it is difficult for the development team to move forward.

When asking about how different customer requirements are prioritized and how to know what to focus on, the following comments were made:

- "Prioritization of requirements is done through a discussion between the different stakeholders. It is impossible to know all the constraints."
- "There is no clear priority at the next level, only prioritization of areas. When we try to cut as much money as we do, we must know what we should focus on and what we can remove."
- "So far it has been pretty clear with the prioritization; the prioritization of space. But now when you go further on in the development you probably have to get more specific."
- "If you want to make a proper product description it must be detailed enough to tell what to sacrifice, for everything we add we need to sacrifice something else. You need to have a value basis, so you know what you should prioritize and what to give lower priority."

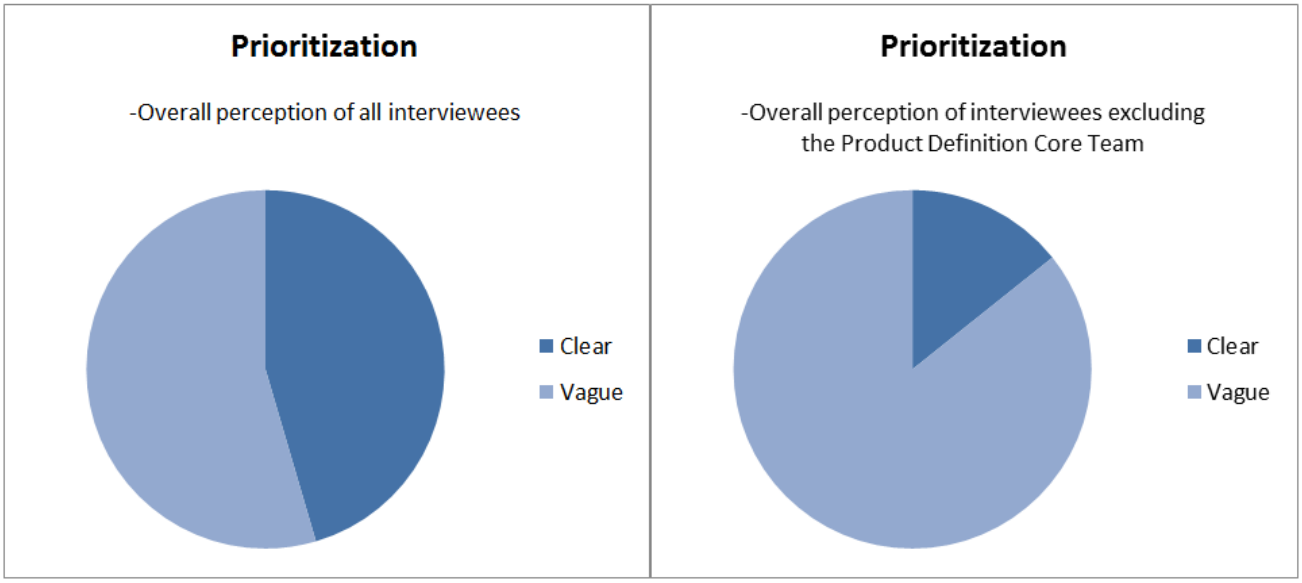

Figure 5.2 The perception of the prioritization in the Product Definition. The chart to the left shows the overall perception of all interviewees. The chart to the right shows the perception of the prioritization excluding the interviewees that are a part of the Product Definition team.

5.6 Balancing & Decisions

Overall the feeling within project A is that one tries to take all requirements, properties, performance and costs into consideration when balancing and taking decisions in different fora. There is however suspicions that the cost targets are very hard to reach and that that might affect the product content. In addition there are some concerns that people make decisions based on personal preferences instead of referring to the Product Definition. There are also some concerns that the design department in some aspects have a very strong voice, that the design department is working on their own and not showing any models during the development process.

- "Within PS&VLM the team has started to become a well-functioning one that knows what we want to achieve and can easily come to a consensus. In previous cases, it has been more difficult to balance where various meetings have been needed to reconcile the product, but in this case the Product Definition provides a good basis so no arguments are needed. It will become a bit harder later in the project when more decisions have to be taken. But I have great faith in the project and see no hesitation. The process is running pretty smoothly, people do not hesitate to hold discussions and communicate within the team."
- "The design department is too strong here. There is a tendency in the single model selection that out of nowhere suddenly a third draft pops up, besides the two chosen models, that looks great but that is way too expensive. When then showing the models to the management they choose the fancy draft since they cannot take in all the information and see all the consequences."

- “I often find that the project might not really have absorbed the information about the clients and the Product Definition, but in many cases people refer to what they think themselves.”
- “Do not understand what occurs at the cost meetings, over hears from meetings how things that are important for the client are to be removed while other features that the customer does not want to pay for are added. For me it is hard to see who is participating in these cost events and hard to understand the decisions that are made.”
- “Do not think that we are completely aligned and fighting for the client. The development is very much based on cost.”
- “We have an ability to do everything and think one-size-fits-all when designing cars, this is not possible. There is certainly a lot of things that you can remove that the customer never notices but it is hard, all are surely trying to do their best. The will/will not in the Product Definition helps in this process.
- “As for decisions, it is unclear how the process is executed, at times one has a very strong voice and sometimes one has no mandate, depends on who is there and if they want to listen.”

5.7 Communication

Virtually all interviewees have listened to the presentation of the Product Definition. Some of the participants from the development departments, but not all, have gone through the Product Guide. The common view is that the Product Definition presentation is interesting and easy to follow, however some critique mentions that the material is too vast. During the interview study the following remarks were made:

- “The presentation of the Product Definition was distinct and easy to follow.”
- “The Product Definition should be 3-5 pages long, and should be a summary of the findings, not describe the whole context.”
- “What has been really good, are the presentations held in the Volvo Hall, the material is easy to grasp. Feels like most have embraced the material, but there are a few exceptions where it feels like to people are developing the car as normal.”
- “It is not enough to show the presentation once but you have to show the material several times otherwise it will be forgotten. New people joins the project all the time and at present it is especially critical to stress the Product Definition; you have to try not to lose focus, it is easy to develop a car as usual when you are stressed, especially when there are so many involved as in a car project.”
- “Those who are close to the core team have good knowledge of the Product Definition, but those further away do not have as good knowledge, but overall the knowledge is good.”
- “What does chunky mean? Does it mean a straight or an angled windscreen? Got to have more clear guidelines so you understand what you want to achieve. If chunky is

what you want, the significance of this must be further explained by some kind of more clear directives or images. For example, one could check with the customers- what is chunky? By showing pictures where customers may tell which design they prefer, if you can then determine that the customers in 90% of the cases prefer a certain design you can get a hint of what to design against and then more clearly communicate chunky to the developers."

5.8 Validation & Verification

Concerning validation and verification there is no testing to ensure the accuracy and fulfilment of the customer requirements. There are however plans to do a digital clinic during the autumn of 2014, where one will look at the design. Comments made on the validation, verification and traceability of recommendations show that:

- "The digital clinic will however come too late to really change anything without affecting the production start. "
- "We have not tried to trace customer requirements in the past. That is something that should perhaps be done on PS&VLM by looking at the property profiles. However, it is difficult since requirements and results are constantly changing, the final product usually differs a lot from the one shown at concept clinics."

5.9 Methods

For project A a workshop was performed in order to be able to conclude the extensive customer research. Further on no specific methods seems to have been used in order to try to follow up the requirements management. There seems however like there exist thoughts on that using more cross-functional activities could improve the requirements management:

- "I think it could be good if as a complement to the Product Definition presentation cross-functional activities were arranged with the product development team and concept leaders where one was given an opportunity to discuss and clearly define the requirements for each department."

6 Analysis

Based on the theoretical framework and empirical data from previous chapters an analysis based on the purpose of the report is presented.

6.1 Customer Needs & Requirements

One of the key factors for success is, as previously stated, understanding customer needs. It is especially important to understand the needs early in the development process. Otherwise there is a risk that changes have to be made later in the project when it may be difficult to introduce changes, and additionally the cost of changes increases the longer the project progresses.

In the case of project A most of the involved employees agree that the explorative customer research and the Product Definition came a bit late. The customer research must be carried out early in the project, before the designing has begun, in order to make sure that the research can actually affect the product design. In this case some features were a bit tricky to implement due to the late timing of the Product Definition. In addition, there were reports that research material was cleaned from information and customer needs that were no longer accomplishable since the product gets more and more restricted as the development of the platform proceeds. This might however lead to a risk that needs that are still accomplishable are not included in the Product Definition.

On the other hand, there lies a risk in performing the customer research too early since the customer needs might change with time. Additionally, one must also consider the fact that the earlier a project starts the more resources it will require. It is therefore in the interest of the managements to minimise the total development time whereas the developers can in most cases never get too much time in the development phase. It is therefore important to understand what is locked in the platform, what needs to be defined early in the project and when this information is needed.

6.2 The Requirements Process

There are several processes for requirements management suggested by different authors within the area. One thing that all seem to stress is the importance of having a clearly defined process, adapted to suit different types of projects, that should be well documented, in order for the process to be repeatable and comparable.

Regarding the overall product development process at Volvo Cars, there are different standards like the VPDS that explains how projects should be implemented. Despite this, it seems that in some cases it is unclear how the process should be executed; what to do when, and who is responsible.

One suggestion was to make the product manager more overall responsible for the product, a person that follows the project from start to goal, has an overall view, keeps track of all requirements and can make sure that the project stays in focus. It is probably more a problem with the definition and description of the process and the role of the product manager than a problem with not having an overall responsible product manager. The main issue seems to be how and by whom decisions are made and whom to address concerning certain issues. This indicates that a better structure, clear descriptions of the process, roles and meeting fora could facilitate the development process a lot especially at gates, milestones and when setting up action plans et cetera.

Additionally, when looking at the process at Volvo Cars one notices that the process lacks some of the most important parts of the requirements process; formulate and arrange the customer requirements these in a structured way, prioritize customer requirements, verify the concepts and validate the requirements. This will be further discussed under the respective headline.

A proposal by one of the interviewees is to start the investigations of different ideas earlier, already in the annual progressive development phase, before the project is initiated, in order to get more time to develop different proposals.

To start the research earlier may be advantageous from several aspects; it may make the development go faster once the project starts, and it may give synergy advantages and cost reductions. Additionally, one could further develop this work by introducing set-based engineering, where the main idea is to develop various solutions and then wait with the decision until all conditions are available. Set-based engineering could thus be used to further reduce product development times, costs and increase the fulfilment of customer needs.

6.3 Manning

When talking about manning and development projects, there is a number of factors are stressed. It is essential that the project team consists of a cross-functional team, that there is a strong ability to manage projects and that representatives from both the marketing side and the development side take part in the customer research.

Here is one area where Volvo Cars really have succeeded in changing the process in a very positive way. In the explorative customer research people from MSS, R&D and PS&VLM participated. One thing one can point out is that it would have been beneficial to also involve the design department in customer surveys. There is also a point of involving the purchasing department in order to be able to get an idea of the customer needs and then be able to use this in the discussions with suppliers. Another thing that could be enhanced is the planning of resources, plan and ensure in the early stage of the process that the proper resources are available so that the development is not disturbed by resource problems. The early

introduction of a cross-functional team also facilitated the creation of a well-functioning team and the collaborative work during the continuing development process.

6.4 The Product Definition

Two main purposes for the requirements specification is that it shall serve as a guide during the development of what should be achieved and that in addition the specification shall be used to measure outcomes and doing evaluations. Looking at the Product Definition and Product Guide one can find a number of areas that could be enhanced, where one by further defining the product content could facilitate and speed up the development process. Looking at the demands for the requirements specification stated by Shefelbine (2002), there are a number of important areas:

- Solution independent – the requirements should specify *what* is needed, but not *how* it should be done. The Product Definition meets this requirement well by specifying will/will not for the product, but not how it should be accomplished.
- Complete – the specification must include all involved areas. It can be concluded that the Product Definition contains all involved areas based on the findings in the customer research and the sum-up done in the workshop.
- Clear – the specification should be distinctly defined to avoid misconceptions. A few people from the development team, especially from the R&D department find the definition too vague. For example: what does chunky mean? In principal all project members find the will/will not in the Product Definition very useful and most employees ask for more information of this type. Clear requirements reduces the risk of changes later in the project which can be hard to accomplish as well as expensive. Clear requirements and product specification could also give advantages when redesigning or changing a part later on and can moreover facilitate the cooperation between different cars and the platform. At the same time one must understand that it is not possible to define everything in the requirements specification. The development must be an iterative process in which different needs are balanced in order to find the best possible solution.
- Concise – only necessary information should be included in the specification. The Product Definition and Product Guide are too extensive to work as a product specification for the developers.
- Quantified – it should somehow be possible to measure if the requirements are met or not, for example by quantitative limits or ranges. For most requirements there are no quantitative limits or ranges. This causes problems during the development process partly by making it difficult for the developers to know what to achieve, and moreover it makes it impossible to ultimately measure whether a satisfactory results has been achieved. The idea from the Product Definition Team is that there should be a dialogue between them and the different units in order to clarify set targets. However, the opinions about this procedure differ. Some people find the process

effective, whereas others think that the procedure does not work and that it is too time consuming. Another idea could be to first give the Product Definition presentation and then allow for a discussion with the Concept Leaders in order to clarify the requirements and the targets.

- Traceable – it should be possible to trace the requirement from the origin to its implementation in the design. It is a bit too early to answer this question yet. However, looking at the current design proposals it seems likely that in many areas the concept can be directly connected to the original requirement.

In some cases one can question how different requirements are set, for example: The car should get a top result in selected objective safety ratings and leadership within Collision Avoidance. At the moment the project A is trying to achieve top scores in the different NCAP evaluations (NCAP stands for New Car Assessment Programme and is evaluating standard for various safety measurements of motor vehicles) by implementing several different solutions in the car. In other words, a lot of energy and money are spent on reaching more than the highest grades in these NCAP evaluations. The questions are however -Is this really a customer requirement or would it be okay to not reach top scores in the NCAP assessments? Is the customer really willing to pay more for the car to reach higher points in NCAP?

However, one can discuss the fact that the requirements seems to be the same in most cases independent of type of car, in this case one could benefit from evaluating the different requirements and maybe setting different requirements depending on car model and version. For example maybe it is okay for the clothing in the cheapest Volvo model to be of slightly worse quality compared to the most expensive Volvo model? If one should be able to decrease the cost one have to be prepared to make reductions in some areas. One way of increasing margins and thereby profits is by daring to take away more content from the cars, and one way to reach this is by introducing more will not in the Product Definition.

A lot of requirements and concepts are set based on competitors, which in one way is a beneficial method since this means that one can easily evaluate what the customer thinks about the different concepts. One can however argue that by only benchmarking what competitors does can never make you better than number two and there might be lost opportunities by looking to much at what the competitors does.

Since it gets more and more expensive to do changes in the product content the further into the project you are, it is important to have clear requirements before the major work in the project starts. Even though the requirements should be set early on in the project it is at the same time it is also important to allow the requirements to evolve and change if needed, e.g.: if the legislation is changed et cetera.

6.5 Prioritization

It is essential to make a prioritization of the requirements since there most often are numerous customer needs and focusing on fulfilling all requirements in the specification most often leads to sub-optimization since the requirements frequently are conflicting.

In the case with product A there are no prioritizations of the customer needs. When asking the interviewees about the three most important requirements the answers are more or less identical but there is no formal prioritization of the different requirements. A well-defined prioritization among the requirements could facilitate and speed up the development process by giving directions on what to focus on. In the case with Product A it would be beneficial to identify the top ten key customer requirements and also be prioritize these top ten among themselves. These top ten requirements can more easily be kept in mind during the development process and thereby one can more easily visualise possibilities and issues in order to try to find the optimum system.

6.6 Balancing & Decisions

One of the most important tasks within requirements management is balancing, which involves balancing different product requirements, properties, performance and cost against each other in order to produce a successful product. Balancing is not an easy task and it the case at Volvo Cars the balancing of product content against product cost is a very difficult issue. The feeling within the project is that one tries to take all requirements, properties, performance and cost into consideration when making decisions in different forums. There is however some concerns that one in some cases does not take the customers opinion into consideration but make decisions on personal preferences. Another point that is mentioned is the fact it is the design department that on their own are choosing from eight to two design models, and as well has the big power at single model selection. In this case it would be beneficial to involve more parties from different functions, to really make sure that one are following the requirements set by the Product Definition Team.

6.7 Communication

Overall it seems like most involved employees has taken part of the Product Definition by either attending the presentations that were given or in some other way have got the most important parts explained. The knowledge about the Product Definition seems to be high close the core team and is gradually decreased the further away from the core team you go. It is important to make the information about the product as accessible as possible, perhaps it would have been good to make the presentation about the Product Definition a mandatory part for all involved in the project, and not something the employees themselves have to book through LAD. In this case, it seems that most have received the information but since

all interviewees are working relatively close to the core team and in many cases have a role of leading character, it may happen that the knowledge is not as good everywhere.

The presentation about the Product Definition gives a good overall picture of the explorative research, the product definition process, the segment, the market and the customer needs. On the whole the spectators find the presentation interesting, but some point out that the presentation contains too much information. Customer needs must be presented in a way so that it becomes easy for developers to use the information during the process. Like previously suggested a short, clear customer requirements specification would be useful, this could consists of a 3-5 PowerPoint slides or an excel sheet, that also could be used during the development process to remind the team of the Product Definition.

One must also consider the fact that interests and vocabularies differ between different functions within the development team which can complicate the communication among the cross functional members. Against this background, it can therefore also be advantageous to use different tools for communicating the Product Definition. For example to explain the word chunky one could use inanimate integrators, different kinds of physical models, sketches, pictures or videos, and also benefit from having discussions in an early stage with Concept Leader in order to clarify the definition.

As stated before it is important that the list of requirements not just becomes something that is created in the beginning of the project and then is forgotten. In this case it seems like one benefit a lot from having a large cross-functional team that has been a part of defining the Product Definition since this team now has the knowledge to remind about the definition in different meeting forums and when decisions are to be taken.

6.8 Validation & Verification

During the process it is of high importance that the requirements are validated and verified. For project A the plan is to validate the design by performing a clinic during the autumn but there are no further plans on how to validate the requirements. Since there in most cases do not exist any quantification for the different requirements this makes it more or less impossible to verify the requirements, and in the cases where one has a set target there are no specified verification methods. Concerning requirements on a more detailed level there seems to be a well-specified verification system and set targets.

6.9 Methods

There exist several different methods that can be used during the transformation of customer requirements. As previously concluded there is no universal method that fits all businesses and in all situations, but the important thing is to find something that fits the specific case depending on the project, time, resources and experience. Looking at project A it seems like Volvo could benefit a lot from introducing different types during the process

which can complement each other in different purposes. Two examples of processes where one could benefit from using different product development methods are when prioritising and balancing the requirements. Tools like QFD, Pugh Matrix, Morphological Matrix, and Kesselring could help in the assessment of interrelationships between requirements and for evaluating concepts. By assessing interrelationships of requirements in an early stage one has the ability to early on get the knowledge of conflicting or enhancing requirements and thereby deciding focus.

6.10 Synopsis

Finally, one essential point to remember is that even if all customer requirements are meet this does not imply that the product will succeed on the market. There are many factors that affect the product success on the market, where one needs to reconcile the operations resources and markets demands in order to find both a product offer, a sales strategy, sale channels, and in the end providing a total offer that can be successful.

7 Conclusion & Recommendations

With the support of the report's previous sections this chapter presents conclusions, which reconnects to the report's purpose and research questions.

It is not possible to draw general conclusions based on this thesis study. A specific case, a new developed process, at Volvo Cars has been studied. The result obtained depends a lot on the specific case and the chosen interviewees. Generally, product development, customer requirements management and requirements management are complicated processes. The beginning of the product development project is fuzzy, there's a lot of uncertainty and it is difficult to identify customer needs as they vary and change. At the same time the customers also do not know what they want in the future. Discovering customers' latent needs are in many cases based on the need to check how customers use the product. A truly successful product is seldom produced based on that customers have articulated the specific need but more to an innovative idea created based on how the product is used.There is no ideal product development process or requirements management method that fits all companies. Instead, one must try to find the best methodology for the specific situation, where the main success factor in this context has proved to be the introduction of some type of structured approach to customer requirements management. To find the best method, it is important to solicit the help from a cross-functional team and take in everyone's opinions and needs in the evaluation process.

The implemented change in the product development process at Volvo Cars with an early explorative customer research where Volvo employees from several different functions got the chance to participate can be concluded to have given positive results. Most people who are involved in project A have a good knowledge of the Product Definition. But when it comes to quality of the Product Definition the opinions differ; some employees are satisfied with the definition and think that it is clear and presented in an effective way, while others think that it is vague and prolix. The important thing here is to note all varying opinions and understand that even if, one on the whole is satisfied with the customer survey and the Product Definition, there is still room for improvement.

First, the Product Definition must be more distinct and explain exactly what is it you want to achieve. All requirements must have targets and means to measure their fulfilment. Furthermore, the requirements should be prioritized so that one knows what to focus on when balancing the product. The presentation on the Product Definition is interesting and useful, and the same goes for the Product Guide, but one should also create a more concise requirements document. The requirements document should in a structured way explain the customer requirements, targets and verification methods and be short enough, for developers to actually take the time to read it.

As previously mentioned, even an excellent list of requirements does not imply that the project will succeed. Key factors for a successful development project is motivation, passion, and communication, and on these there is plenty of confidence in project A. On the whole, there is great confidence in the project and the team, which in many ways can contribute to success.

At last, one can conclude that it is not easy to work with customer demands. However, if done the right way, companies have much to gain by creating the ability to produce products that customers want, which is increasingly important with the growing global competition, the fast evolution and diversification of technology and decreasing product lifecycles.

8 Discussion

Despite the challenging nature of product development and requirements management, literature on the latter subject is relatively scant. There are barely any published studies on different types of methods or success factors within requirements management. Furthermore, there are extremely few studies on traceability and how requirements are transformed into a product specification and solutions, and the other way around. The lack of previous studies within the area makes it hard to draw general conclusions.

The thesis project was conducted under a too short time period to be able to arrive at any final conclusions. To be able to really answer all research questions, the requirements specification would have to be compared with the actual car. In this case the projects is in a far too early stage of the development process for anything to be said about the final product. Even the set product features can be changed during the long time that is left until the launch of the final product, and until then a lot can be changed due to undiscovered issues or cost optimization. Furthermore, to be able to make a comprehensive and fully consistent analysis one would have to interview even more people, those from complementary functions and positions. In this case the result is highly dependent on the interviewees and if other people had been interviewed, or another project had been studied it is very likely that the result would had differed. It would therefore in this case be desirable to make a complementary survey where one would compare the final product to the Product Definition and associated with this also conduct an interview study in order to investigate what the outcome depends on and what could be done better in future projects.

What can be said is that the most important factor regarding requirements management is however to introduce some method and in a structured way organise the requirements, the targets and the verification methods. Additionally, one should keep the same process in order to be able to compare different projects and results, and lastly it is important to verify and validate the result.

Further research in this area would be beneficial, particularly studies of various processes, methods and success factors concerning requirements management.

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Appendix

A. Timeframe

The work on the report is expected to continue for a total of 20 weeks from January 2014 to June 2014. Figure 3 shows a schematic Gantt chart of the time spent on various activities during the creation of the report.

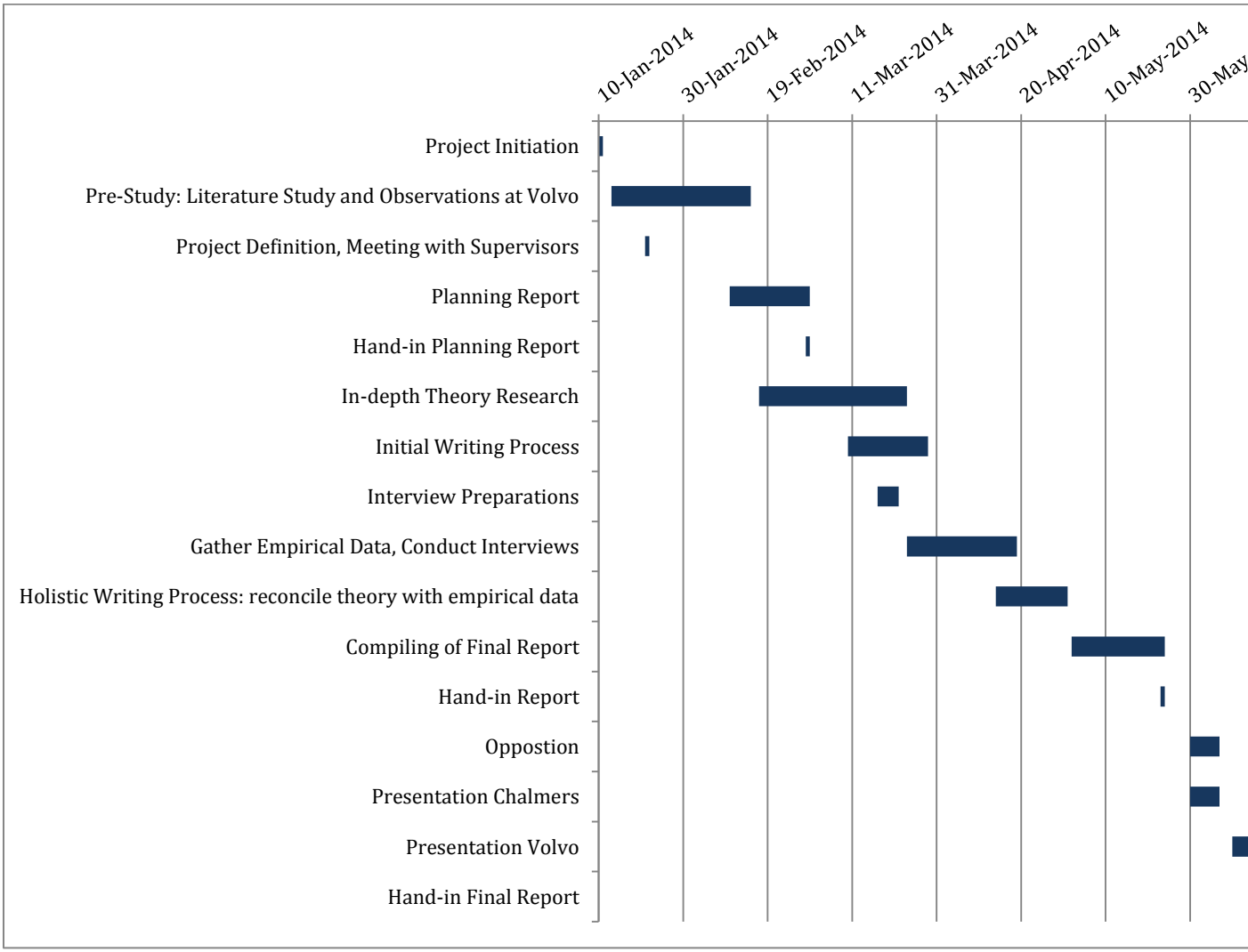

Figure 0.1 Gantt chart showing time spent on various activities during the creation of the report.

B. Interview Guide

Interview Guide - Product Definition Core Team

Name:
Department:
Title:

- **Purpose:** I am doing my thesis project here and I am studying the A project. The purpose with this interview is to investigate how the information from the customer research is used during the development phase that is how customer needs are transferred into technical requirements.

- **General:** I will not use your name in presentation nor in the report; however, the results might be presented together with your role description. After the interview I will give you a chance to confirm the information you have provided.

- I have signed secrecy commitments and will not publish anything which is secret for the company, additionally all information will be confirmed by Henrik Green and before being presented or published.

- If it is okay I would like to record the conversation?

Introduction

1. What is your role in the company?
2. How long have you worked with similar tasks?
3. How long have you worked here?
4. What is your background? (Studies/Previous experience)
5. How long have you worked with project A? What is your specific role within the project?
6. Do you share your work time between different projects?

Background - Data Gathering

1. How was the research locations chosen?
2. How were the participants among Volvo employees chosen for the customer? From which departments were the participants?
3. Did you take part in any of the customer research surveys?
4. What would you say was the most valuable outcome from the customer research?
5. Could you notice any differences between different markets?
6. Would you say that customer surveys were conducted at the right time in relation to the project?
7. Do you have any suggestions on how to improve the data gathering process?

Customer Needs & Requirements

1. Please rank the three most important requirements for A, start with the most important. What are the targets for these requirements?
2. How are different customer requirements prioritized? How should the engineers know what to focus on?
3. Are different customers/markets valued differently?
4. How are customer requirements coordinated with other requirements (such as engineering, manufacturing, legal requirements et cetera) for the product?
5. How are the targets for each requirement decided?
6. How do you plan to verify the requirements (to check that the output in the development process meets the specified requirements)?
7. How do you plan to validate the customer needs (confirming the requirements against the product needs)?
8. In your opinion are there any differences between how the requirement setting has been made in the project A in comparison with previous cases?
9. What can cause the requirements to change during the development process? Have any there been any changes of the requirements for project A? What were the effects of the changes?
10. Do you have any ideas on how to improve the process of requirement specification and management?

Communication

1. How was the information from the customer research shared within the project group?
2. Have different persons/departments received the information in different ways?
3. Who has received the information from the customer research?
4. How are the established requirements communicated to the project group?
5. How are the prioritizations of requirements communicated to the project group?
6. Did you use any mediating tools to clarify the information from the customer research, eg: personas, symbols, prototypes, pictures?
7. How would you say that the information regarding the customer research was received?

Management and decisions

1. Do you think that the project team has understood the customer needs?
2. Do you think that the project is working towards reaching the customer needs?
3. How would you say that communication/cooperation worked within the project group? Did they seem to work against the same targets
4. Who have the power to make decisions in this phase of the project?
5. How did you validate the decisions? (How did you confirm that the decisions were right?)
6. What role do you feel that politics play when it comes to balancing of the product content?
7. Do you think that personalities and individuals' drive have large impact when balancing the product content?

Round off

1. Is there anything else you would like to add? Do you have any questions?
2. Can I come back to you with additional questions if needed?

Interview Guide - Product Development

Name:
Department:
Title:

- **Purpose:** I am a student from Chalmers University of Technology, where I have a bachelor in Industrial Engineering and Management and a master in Product Development. Right now I am doing my master thesis project here and I am studying the A project. The purpose with this interview is to investigate how the information from the customer research is used during the development phase that is how customer needs are transferred into technical requirements.

- **General:** I will not use your name in presentation nor in the report; however, the results might be presented together with your role description. After the interview I will give you a chance to confirm the information you have provided and how it has been interpreted.

- I have signed secrecy commitments and will not publish anything which is secret for the company, additionally all information will be confirmed by Henrik Green and before being presented or published.

- If it is okay I would like to record the conversation?

Introduction

1. What is your role in the company?
2. How long have you worked with similar tasks?
3. How long have you worked here?
4. What is your background? (Studies/Previous experience)
5. How long have you worked with project A? What is your specific role within the project?
6. Do you share your work time between different projects?

Background - Data Gathering

1. Did you take part in any of the customer research surveys?
    a. If yes; What would you say was the most valuable outcome from the customer research?
2. Did you take part in the Product Definition Workshop?
3. Would you say that customer surveys were conducted at the right time in relation to the project?

Customer Needs & Requirements

1. Do you think that the Product Definition and the requirements that are stated are clear?
2. Please rank the three most important requirements for A, start with the most important. What are the targets for these requirements?
3. How are different customer requirements prioritized? How do you know what to focus on?
4. How are customer requirements coordinated with other requirements (such as engineering, manufacturing, legal requirements et cetera) for the product?
5. How are the targets for each requirement decided?
6. Would you say that the requirements specification contains the most important requirements for the product?
7. In your opinion are there any differences between how the requirement setting has been made in the project A in comparison with previous cases?
8. Which are the most important requirements concerning your area?
9. How do you work to reach the requirements?
10. How do you plan to verify the requirements (to check that the output in the development process meets the specified requirements)?
11. What can cause the requirements to change during the development process? Have any there been any changes of the requirements for project A? What were the effects of the changes?
12. Do you have any ideas on how to improve the process of requirement specification and management?

Communication

1. In what way have you received the information regarding the "Product Definition" and customer needs for A?
2. Have you read the Product Guide?
3. Do you think it was easy to understand the information that was given?
4. Would you say that the information regarding the customer research was interpreted in the same way within the project group?

Management & Decisions

1. Do you think that the project team has understood the customer needs?
2. Do you think that the project is working towards reaching the customer needs?
3. How would you say that communication/cooperation worked within the project group? Did they seem to work against the same targets?
4. Who have the power to make decisions in this phase of the project?
5. How did you validate the decisions? (How did you confirm that the decisions were right?)
6. What role do you feel that politics play when it comes to balancing of the product content?
7. Do you think that personalities and individuals' drive have large impact when balancing the product content?

Round off

1. Is there anything else you would like to add? Do you have any questions?
2. Can I come back to you with additional questions if needed?