CHALMERS
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How to implement Production Early Involvement

A qualitative study at Volvo Cars

Bachelor's Thesis in the Bachelor's Programme Economics and Manufacturing Technology

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Gothenburg, Sweden 2018
Report No. E 2018:056

BACHELOR'S THESIS E 2018:056

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Cover:
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Chalmers Reproservice
Gothenburg, Sweden 2018

ACKNOWLEDGMENTS

This thesis work has been accomplished during the spring term of year 2018, with the content of 15hp at the department of *Technology Management and Economics*, at Chalmers Technical University. The thesis work is written at the company Volvo Cars Corporation in Torslanda, within the department Industrial Engineering where Ulf Sarge has been our supervisor together with Ann Mårtensson. We would like to thank them for the trust and all help that we have received, which made it possible for us to reach this result. Their help has been exceptional in guiding us to contact the right people and also give us the needed knowledge of Volvo to understand the content of the work. Of course, we also want to thank Volvo for the big opportunity to travel to Gent in Belgium to do an important part of the study there.

Additionally, we would like to thank our mentor at Chalmers, Cecilia Åberg, for the support and advice that made us work in the right direction towards the result. Without Cecilia, our fellow students and the tutors at Chalmers Writing Centre this thesis work would not reach this high academic level.

Finally, we want to thank all the employees at Volvo Cars in Torslanda, Gent and Skövde that we had the honour to interview. Without the interview answers, guided tours and help we would never have been able to reach this result.

How to implement Production Early Involvement
- A qualitative study at Volvo Cars

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ABSTRACT

This thesis work has been performed at the company Volvo Cars Corporation who produces cars of the brand Volvo for a global market. Today the plants have operational focus and, strategy focus and process development has been within the department Manufacturing Engineering. In order to increase ownership for the long-term plant development, one area to improve is Production Early Involvement. Therefore, the Management Group now wants the plants to take greater responsibility and ownership in early phases. The change in focus should be done by an earlier involvement and clearer requirements in new projects. To be able to work with their strategy, Volvo Cars in Torslanda (VCT) has agreed on four focus areas, where "Early Involvement" is one of them. Thereby, this thesis work aims to help the company find out "How can Volvo Cars in Torslanda be more efficient in their work with Production Early Involvement?".

The study is done by both interviews and observations; these have been analysed and discussed continuously during the work. When all the interviews and most of the observations were made, a greater analysis of the material was done to create the descriptions of the current and desired future states. The differences were then analysed in the gap analysis, with the focus on two areas, Information and Organisation. Literature studies have been done in parallel with the thesis work to get a better understanding of the content from the observations and interviews. Additional knowledge about the company was collected from the internal business management system.

Finally, the outcome of the study was the final recommendations given to the company. These included recommendation points within four subcategories: Requirements, Communication & Collaboration, Organisation and Competence. The recommendations are given to improve the work within the subcategories with help of work methods and organisational changes. There are several recommendations that could be adapted directly by the company. To be able to implement these the Management Group first needs to evaluate how the organisation will look and the prioritisation of the given recommendations.

Key words: *Production Early Involvement, communication, collaboration, organisation, long-term strategic work, product development.*

TABLE OF CONTENT

ABBREVIATIONS

A-shop	The part of the plant that produces the body
APAC	Asia Pacific
B-shop	The part of the plant that pain the body
BC	Business Confirmation
BMS	Business Management System
C-shop	The part of the plant that assemble the parts to a complete car
DFMA	Design for Manufacture and Assembly
FMEA	Failure Mode and Effect Analysis
FSR	Final Status Report
IE	Industrial Engineering
J1	Job #1
KPI	Key Performance Indicators
LR	Launch Readiness
LS	Launch Sign-Off
M&L	Manufacturing and Logistics
ME	Manufacturing Engineering
MP1	Mass Production
P&Q	Product & Quality
PC	Program Confirmation
PP	Pilot Production
PP20	Plant Performance year 2020
PS	Program Start
PSI	Program Strategy Intent
PSR	Program Strategy Finalized
PTR	Program Technology Intent
PV-building	One of the head office buildings in Torslanda
QDFIPS	Quality, Delivery,Finance, Improvement, People & Sustainability
SM	System Mule
TPS	Toyota Production System
TT	Tooling Trial
VCT	Volvo Cars Torslanda
VCG	Volvo Cars Gent
VCCH	Volvo Cars Charleston
VCCD	Volvo Cars Chengdu
VCDQ	Volvo Cars Daiqing
VCES	Volvo Cars Engine Skövde
VCEZ	Volvo Cars Engine Zhangjuakaou
VCLQ	Volvo Cars Luqiao
VCMS	Volvo Cars Manufacturing System
VP	Verification Prototype
VPDS	Volvo Product Development System

GLOSSARY

Blue collar workers	Employees within the production belonging to a specific collective labour agreement
Car project	When a new car is developed, or an existing car is edited
Control Tower	A meeting for every shop to review status for the project during launch
day@work	An office structure that include no pre-decided seats or desks for anyone
Industrial project	Projects within the production plant that aims to improve the conditions for building cars.
Isolated islands	Where operators are not being used efficiently
Kaizen	Continuous improvements
KPI	Key Performance Indicators, measurable value showing how effectively the company is achieving key business objectives.
Logic meeting	A meeting initiated by ME to involve other departments in early phases to evaluate different phases in the projects.
ME Commodity	A part of the department ME, develop processes
ME Core	A part of the department ME, work with the early phases
ME tooling & equipment	A part of the department ME, develop and design tools and equipment for production
Non-product projects	Industrial projects, projects that are not related to new cars
Plant	Where the production of products takes place
Production early involvement	The name of the project that the division Industrial Engineering runs to become a part of new car-projects in an earlier stage
QDFIPS	The KPIs' of Volvo is measured in the areas Quality, Delivery, Finance, Improvement, People & Sustainability.
Shop	A part of the production plant, divided into the processes for: Body (A-shop), Paint (B-shop) and Final Assembly (C-shop).
Stakeholder	A person who holds information relevant for this thesis work.
White collar workers	Employees working as a civil servant with another collective labour agreement than blue collar workers

DISPOSITION

Chapter 1- Introduction
The thesis work is introduced in this chapter by background, problem definition, purpose, limits and question formulation.

Chapter 2- Method
Describes the different methods that have been used to collect data and information for the result of this thesis work.

Chapter 3- Theory
A sample of theories that helps to describe and find the result in this study. Aims to help the reader understand the result and recommendations.

Chapter 4- Current state
A description of the organisation, how project work is done at the moment and the result of the interview questions about the current state.

Chapter 5- Desired future state
A description of how Volvo Cars Corporation wish to work in the future, according to the result of this study. It contains of the parts: Early Involvement and result of the interview questions about the desired future state.

Chapter 6- Gap analysis
The analysis of the interview data and the gap between the current state and the desired future state. To analyse the gap, two specialised areas are considered together with their subareas.

Chapter 7- Recommendations
The final recommendations are given to answer the question “How can Volvo Cars in Torslanda be more efficient in their work with Production Early Involvement?”

Chapter 8- Conclusive discussion
A conclusive discussion that includes a discussion of both the result and the method, also a reflection of possible further studies.

1. INTRODUCTION

To introduce this thesis work this chapter will contain a background, including a description of the company and the issue of the problem formulation. Additionally, there is a problem definition, a stated purpose, limitations and the question formulation.

1.1 Background

Volvo Cars Corporation (VCC) is a global company that produces and retails cars of the brand Volvo to both private individuals and other companies in the whole world. One of Volvo Cars' oldest production plants is located in Torslanda (VCT), in Gothenburg, Sweden. Furthermore, the car production is located in China, the USA and Belgium. In China there are plants in Chengdu (VCCD), Daiquing (VCDQ) and Luqiao (VCLQ). In USA there is one plant in Charleston (VCCH) and in Belgium one in Gent (VCG). Apart from the plants that produces the cars, VCC also has plants producing parts of it. For example, the engine, which is produced both in Sweden and China. These engine plants are located in Skövde (VCES) and in Zhangjuakaou (VCEZ).

The production in VCT started in 1964, since then many different cars have been produced. Today, XC90, V90, V90CC, V60 and XC60 are the models being produced. These are all cars at the Scalable Product Architecture (SPA) platform, which means they are built on the same base. The capacity right now is to produce 290 000 vehicles per year, and there are approximately 6 600 employees working within the plant. Within the production plant the production process is divided into three different shops. The A-shop produces the body, B-shop is the paint shop and C-shop is final assembly. In Torslanda there are additionally other departments like Materials and Logistics, but also e.g. Special vehicles but they are not relevant for this thesis work.

Volvo Cars have three main clusters: Product Creation, Consumer Experience and Manufacturing and Logistics (M&L), that also describe their core processes. The different departments are therefore connected to one of these clusters depending on their main tasks. At VCC in Gothenburg the business is divided into head office and production plant. At the head office there are different global departments that work within all the clusters. They work with the development of the car projects before the production can start in the plant. For example, departments such as Product & Quality (P&Q) and Strategic Product Planning, work within the Product Creation process. The work of Manufacturing Engineering (ME) starts during the Product Creation process and belongs to the M&L process.

During P&Q's work the car is developed and verified in a virtual stage to reach design and functional requirements, that later are tested in physical tests, closer to production start. ME is responsible for preparing the manufacturing process, including tooling and equipment. Before the mass production start, Industrial Engineering (IE) and its subdepartment, Plant Launch, gets involved to ensure that the production will flow as planned. The work of IE includes for example balancing the stations and Plant Launch is educating the employees during the launch of a new car. Besides the new car projects IE is also involved in the daily production and, together with ME responsible for the technical solutions. The production plant and the local department Industrial Engineering (IE) works within the core process M&L.

1.2 Problem definition

Volvo Cars has grown over the latest years and all the plants, globally, have had mostly

operational focus. Now the M&L management group wants the plants to take a greater ownership and responsibility, in order to work more strategically. In the strategy work at the plant at VCT, four focus areas have been chosen to work with. These areas are Leadership, Competence & People, Volvo Cars Manufacturing System (VCMS) Execution and Early Involvement.

Within the area *Early Involvement* VCT is working with the problems that often occur in the product creation processes, where the requirements from the production plant and the local division IE, do not reach the product creation process. This results in production solutions that might not correspond with the solutions the plant would prefer. For example, problems could arise within areas such as tools, layout or ergonomic issues. When IE gets involved, it is often too late to make these changes since investment decisions are already made, the car and equipment are constructed and in the pre-production phase. To solve this problem IE wants the plants requirements secured by being included in the project in an earlier phase of the creation process. The project *Production Early Involvement* is mainly run by two employees at the IE division, where the first person is responsible for the long-term strategies and the second one for coordinating and leading industrial projects. *Production Early Involvement* aims to help Volvo Cars to be more efficient in the work with projects, these are mostly car projects, but those can also be industrial projects.

This thesis work will be a part of the Production Early Involvement project, which will complement the project with interviews made with stakeholders within the concerning departments. The result of these interviews, together with observations, will describe a current state and a desired future state that is concurrence with Volvo Cars vision, where this report aims to find recommendations to decrease the gap. These recommendations will focus on processes, information flows, organisations, roles and responsibilities, that will help mainly VCT to be more efficient in the work with Production early involvement. Hereby Volvo Cars AB will be titled as “Volvo” or “the company”, Torslanda as “VCT” and Gent as “VCG”.

1.3 Purpose

The purpose of the thesis work is to influence Volvo’s future work to make the production flow as efficient as possible, based on “design around the operator”. This will be done by looking at how the plants and IE can communicate their requirements earlier in the creation process which will lead to more efficient production solutions.

1.4 Limits

The main focus is on the plant VCT, where the study is performed. To get a more global perspective benchmarking was made at VCG and VCES. From VCT the results will be described by the perspective from the departments IE, ME, P&Q, Maintenance, Production and Logistics. The result from the benchmarking at VCG, is only described from IE’s perspective. The input from VCES will only be described from ME’s perspective, since they do not have an IE department. Therefore, this study does not represent the global situation at all the plants.

1.5 Question formulation

How can Volvo Cars in Torslanda be more efficient in their work with Production Early Involvement?

- In what areas is the gap between the current state and the desired future state?
- What recommendations could be given to the company to decrease the gap?
- With help of the recommendations, how can Volvo Cars in Torslanda be more efficient in their work with Production Early Involvement?

2. METHOD

The study is divided into three main parts, a description of the current state, a desired future state and a gap analysis that will result in recommendations to the company. During the study both interviews and observations have been made, these have been analysed and discussed continuously during the work to be able to adjust the method, such as determining additional interview persons. When all interviews and most of the observations were done a greater analysis of the material was done to perform the descriptions of the current and desired future state. A gap analysis, which will be clarified further down in the thesis work, was done within two areas which have been chosen together with the advisor at Volvo. Literature studies have been done parallel to the thesis work to get a better understanding of information from the observations and interviews. An overview of the method is shown in figure 1 below.

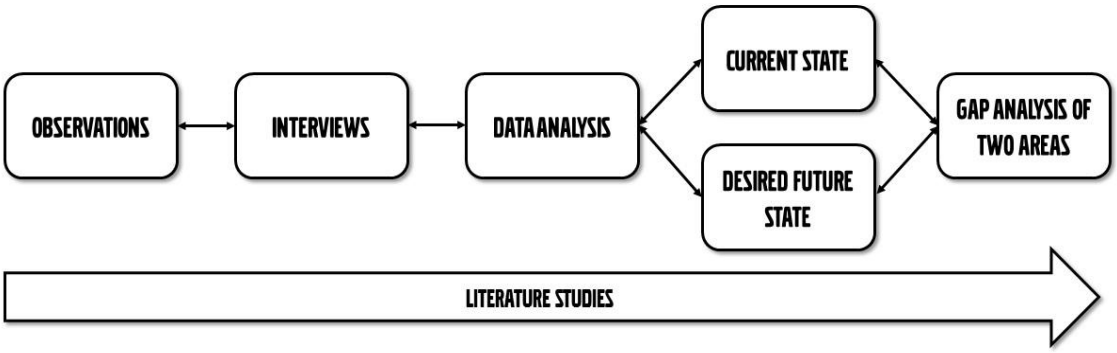

Figure 1. Overview of the working process for the thesis work. The writers' own original figure.

2.1 Data gathering

This study is based on both primary data and secondary data, primary data meaning information being published for the first time and secondary data meaning information that points back to several primary data sources (Umeå universitetsbibliotek, 2018). Primary data in this study was collected from interviews and observations while secondary data was used for literature studies.

There are two type of methods to collect information, qualitative and quantitative, where qualitative methods includes interviews and observations, and quantitative methods are focused on numbers and mathematical models (Eliasson, 2013). A benefit with the use of qualitative studies is that they can show a good picture of the complete situation and give a better understanding for social processes. Performing qualitative studies can also give a better picture of the individuals' viewpoints and make a good launching point for theory construction (Holme & Solvang, 1997). This study is based on qualitative methods with both interviews and observations to get a description of the current state and a desired future state. Quantitative methods are not used in this study since it would be hard to collect information about the current state and a desired future by this method.

2.1.1 Observations

Observations are used as a method for ethnographic studies at the company, which means a better picture of social interactions and the culture is formed (Christoffersen & Johannesson, 2015). The observer can use two different roles, either open or hidden observations; open

observation means that the attendees know and accept that they are being observed, while during hidden observations the attendees are unaware of the observation (Holme & Solvang, 1997). Observations can also be divided into attendance and non-attendance, the first meaning that the observer participates in the observations and can affect the situation and the second meaning that the observer is not included in the group (Christoffersen & Johannessen, 2015).

To get a better understanding of the organisation, the observations made in this study were performed in various ways in different areas. Open and non-attendance observations were made by tours through the different shops together with employees knowing the different processes. By making these observations, a better understanding of the organisation and how the shops work differently was gained. This was important for the work because it helped to explain differences in the interview answers depending on what shop the stakeholder belongs to. To understand how the company works with projects, attendance observations were made when the writers attended to a two day project management course. The course was for employees who work with projects within the plant. This gave knowledge about project work at Volvo and also led to interactions with employees from the company which helped to give a better picture of the organisation.

Another observation that was made was the visit to the plant at VCG where the writers got the chance to meet employees and see how the IE organisation at VCG looks. At VCT the writers attended to the reveal event of the new V60. The writers also visited a Strategy day together with ME, where they presented how an ideal plant could look. Together these observations helped to form a better understanding of the organisation and also its culture.

2.1.2 Interviews

There are three different types of interviews: unstructured, semi structured and structured. In the study of qualitative methods different definitions and standards of these methods can be used; below are the definitions which will be used in this study (Runa & Davidsson, 2011).

Unstructured interviews are informal and usually about a decided theme or area but do not follow certain questions; they can be seen more as a normal conversation. Unstructured interviews can both take place at planned occasions but can also happen unplanned, for example a spontaneous conversation can give important information during an observation (Christoffersen & Johannessen, 2015).

Semi structured interviews are based on pre-selected questions, but the answers can be open. The answers during a semi structured interview can be different and are not depending on an answer sheet with different options, so the answers can depend on how the respondent has interpreted the questions. Normally standardised questions are used for all the respondents to make the answers from different respondents easier to compare (Christoffersen & Johannessen, 2015).

Structured interviews are the most formal interviews and usually consist of both standardised questions and fixed answer options (Christoffersen & Johannessen, 2015). To get a reliable result it is important to have good documentation of the respondents answer, this can be done by for example recording the interviews and afterwards writing down the answers to get a better overview (Eliasson, 2013).

During this study both unstructured and semi structured interviews have been used. Initially unstructured interviews were performed with some of the stakeholders within the IE organisation to get a better picture of the organisation. This included a meeting and presentation with the IE management group where all the members shortly presented

themselves and their roles within IE. These interviews were used to form more specific questions for the semi structured interviews. Unstructured interviews also took place together with two stakeholders working with Strategic Product Planning where the interviews were focused on early stages in projects. Another unstructured interview, which could be seen as benchmarking, was together with the director for Manufacturing Engineering at VCES. This interview was performed on Skype and focused on the organisation at VCES and projects in early phases. See table 1 below for an overview of the unstructured interviews and the interviewed stakeholders. Spontaneous meetings with employees at the company that led to conversations could also be seen as unstructured interviews.

Table 1. Roles of the interviewed stakeholders for unstructured interviews.

Strategic Product Planning	**Volvo Cars Engine Skövde (VCES)**
Vice President Product Strategy	Director Manufacturing Engineering
Product Strategy Manager	

Questions for the semi structured interviews were formed based on information from the unstructured interviews, internal information from the Business Management System (BMS) and observations. The interviews were performed mostly within the IE department that belongs to, M&L unit, which also includes ME, Production, Maintenance and Logistics. Some interviews were also performed together with P&Q which belongs to the Product Creation cluster. The questions where standardised but differently directed depending on what department the respondent belonged to, this resulted in seven different templates, where two of them were translated to English. For the department IE two templates were used, one for the IE Management Group and one for the process engineers. Different question templates were also used for the departments ME, Production, Maintenance, Logistics and P&Q. The interviews were divided into three parts, the first about the current state, the second one about a desired future state and the last part about the gap in between. See Appendix for an example of one interview template. The only difference between the different templates were that the questions about the departments were differently directed. For example the question for IE was: “How are requirements communicated from your department to ME today?” and for ME the same question was “How are requirements communicated from IE to your department at ME today?”. Therefore, all the templates are not included in the appendix.

To get balanced answers interviews were performed with directors from the A-shop, B-shop and C-shop for the departments IE, ME and Production. Interviews were also performed with the complete IE management team, apart from the two advisors that are included in the thesis work. One process engineer from each shop within IE were also interviewed. Furthermore, relevant stakeholders from Maintenance, P&Q and Logistics were also chosen for interviews. Se table 2 for an overview of the interviewed stakeholders. The choice of stakeholders started with IE where the thesis work is performed, stakeholders at the other departments were chosen with help from organisation charts and role descriptions, together with help from the advisor.

Table 2. Roles of the interviewed stakeholders at VCT.

Industrial Engineering (IE)	**Manufacturing Engineering (ME)**
Senior Director IE	Senior Director ME A-shop
Senior Manager IE A-shop	Senior Director ME B-shop
Senior Manager IE B-shop	Senior Director ME C-shop
Senior Manager IE C-shop	Director Concept & Program Management
Plant Launch Director	
Operational Development Process Owner IE VCT/VCG	**Maintenance**
Efficiency Coordinator	Director Plant Maintenance
Senior Advisor Strategy	
Senior Manager VRT	**Product & Quality (P&Q)**
Senior Process Engineer A-shop	Director Concepts, Functions & SA
Senior Process Engineer B-shop	Senior Director Technology & Program Management
Senior Process Engineer C-shop	
	Logistics
Production	Manager Plant Logistic Engineering
Senior Director A-shop	
Senior Director B-shop	
Senior Director C-shop	

All the interviews were performed individually and the time for each interview was approximately 30-45 minutes. Most of the interviews were performed in Swedish, apart from some stakeholders who primarily speak English. To document the interviews most of the interviews were recorded and relevant answers where summarized to get a better overview when comparing the interview answers. The answers were then used to describe how the current state looks, how a desired future state would look, and were also used to find the gap inbetween to get a understanding for what changes could be needed to reach the desired future state.

2.1.3 Benchmarking in Gent

Benchmarking was made in the form of interviews, during a two day visit, at the plant VCG. The interviews were made with stakeholders within the IE management group and Plant Launch, which is a separate department at VCG (see further description of the organisation in Chapter 4.1.5.2). These interviews helped to get a more global perspective, since the plants wants to align and work in the same direction. The questions used for these interviews were the same as for IE at VCT apart from some questions that were adjusted to suit the VCG

organisation. Using the same questions both at VCT and VCG enables the answers to be compared and more reliable. All the interviews were performed individually, in English, and took approximately 30 minutes each.

Due to time limitations, the same number of interviews was not performed at VCG as at VCT. The choice of stakeholders was made together with the advisor and included all the members of the IE management team as well as Plant Launch. In Table 3 below an overview over the interviewed stakeholders at VCG is shown.

Table 3. Roles of the interviewed stakeholders at VCG.

Industrial Engineering (IE)	**Plant Launch**
Senior Director IE	Plant Launch Director
Senior Manager IE A-Shop	
Senior Manager IE B-shop	
Senior Manager IE PPE/VRT current models C-shop	
Senior Manager IE PPE forward models C-shop	
Senior Manager IE Process engineering C-shop	
Senior Project Manager IE	

2.2 Literature study

The literature study is based on information from different sources, both internal and external information. Internal information was mostly found in the BMS where internal information about the company is stored. Other information was received from meetings and the advisor, such as powerpoint presentations. Apart from internal information, external sources were used such as books, e-books and articles. As a starting point literature from previous courses within the students education have been used, for example from the courses Lean Production, Quality and Operations, Work Organisation and Project Management. Other books and articles have been found mainly through the library Gotlib and Chalmers library. Some literature was also found through looking at previous thesis works within similar areas to find sources within relevant areas.

Examples of search words: *“research methodology”, “organisation”, “design for manufacturing”, “lessons learned”, “go to gemba”, “lean”.*

2.3 Analysis of data

As a method of analysing the large amount of information collected from the qualitative interviews a modified version of Affinity Diagrams was used (Guliherme Santa-Rosaa & Fernandes, 2012). The steps in the method used in this thesis work is presented in figure 2 below.

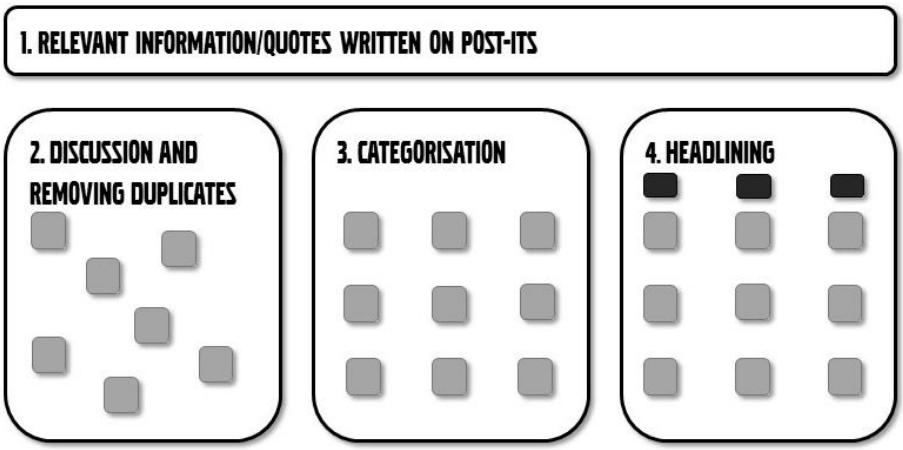

Figure 2. Overview of the method for analysing material collected from interviews. The writers' own original figure.

1. Information collected from interviews was reviewed and important information or quotes were written down on post-its. These post-its were put all together on a wall for an overview.
2. Duplicates were **removed** and discussion about the material started.
3. The post-its were sorted by cause and effect into categories and subcategories.
4. Headlines for each category were written.

2.4 Method evaluation

Method evaluation includes the parts source criticism, reliability and validity. This was important to understand how the result has been obtained and the work has been performed.

2.4.1 Source criticism

To get reliable information from the different sources, source criticism has been used. There is no definitive method for source criticism, but the important part is to look at the whole, for example the writer, content, reliability, target audience for the source, etc. (Umeå universitet, 2016). To start with the source criticism an overview over the collected sources was made to understand what information was available within the area. Because it is never possible to look at all available material, it is important to understand that the information collected might be limited to a certain direction (Holme & Solvang, 1997). To decrease the risk of this the writers have searched for different sources by, for example, not using only one searchword but several within the same area. It is also important to understand who have written the source, why and when, which can give an explanation to how it describes reality (Holme & Solvang, 1997). By using several sources within each area from different time periods the reliability of the material increases because different people can have different interpretations of reality.

A great part of the literature used are articles found from the search engine *Summon* where only reviewed material is published. Many of the books come from the publishing house "Studentlitteratur AB" where all the books are based on science (Studentlitteratur AB, 2018). When looking at other sources the writers used their competence about source criticism which partly has been learned through an online module from Chalmers Library with the focus on source criticism, academic honesty and copyright.

Source criticism is not only used on external sources such as literature but is as important on the internal information such as the BMS and other internal documents, which cannot always be seen as univocal and also needs to be questioned. For example, the BMS and documentation might not always reflect the perspective viewed from the interviews.

2.4.2 Reliability

Reliability is about the internal characteristics of the essay, for example how the interview questions are formed so that they measure the same thing through all interviews (Björkqvist, 2012).

The result of both the interviews and observations rely on the situations which means the result depends on how the writers have comprehended the situations and also how the interviewed person interpreted the questions. This also means it can be hard to get the exact same result doing the research again. To minimise this risk, interviews done in this study has been performed with the same interview questions to all the respondents. The only difference was that some of the questions were differently directed depending on what department the respondents belong to. This has been done to make the answers easier to compare and the result more reliable.

2.4.3 Validity

Validity is about external characteristics and ensuring that the test actually measures what it is supposed to (Björkqvist, 2012).

The result of this study depends on the observations made but mostly on the answers from the interviews. To be able to get answers describing the right thing it is important to use relevant questions, it is also important to be able to analyse the answers in a true way and filter out irrelevant answers. To secure the validity of the interview questions, they have been made together with input and help from the advisors both at Volvo and Chalmers. Another important aspect is that the right people have been interviewed, because different people have different views on the problem. All the persons who have been interviewed have been chosen together with help from the advisors, which could affect the result. To minimize the risk of this having an impact on the work, the writers also have read role descriptions and chosen some people by themselves.

3. THEORY

The theory chapter includes different theories that are relevant and helps to increase the understanding of this thesis work.

3.1 Organisation

An *organisation* is defined by its rate of formalisation, with rules, instructions and legal agreements. The more formal it is, it differs from a group and gives different conditions for the work. Characteristics of organisations are the administrative rules, valuation and the work spread that together creates coordination and target achievement (Lindkvist, Bakka & Fivelsdal, 2014). Organisations can be found in all parts of the society, both in the private and public, where they can have different aim, e.g. economic, interest or religious.

A more specialised form of *organisation* is the *work organisation* where business and assignments are divided due to their function (Börnfelt, 2017). People that work in the *work organisation* are divided into groups to maximize the efficiency of their efforts; these form the organisational structure. According to Pinto (2016) the *organisational structure* consists of three key elements:

1. Organizational structure designates formal reporting relationships, including the number of levels in the hierarchy and the span of control of managers and supervisors.
2. Organizational structure identifies the grouping together of individuals into departments and departments into the total organization.
3. Organizational structure includes the design of systems to ensure effective communication, coordination, and integration of effort across departments. Pinto (2016)

There are different ways to structure an organisation, the most common ways are functional structured organisations, project organisations and matrix organisations (Pinto, 2016).

3.2 Project work

Characteristics for a *project* are that the time for it is defined by the start and end; it also needs to have a defined goal and the resources should be decided previously (Börnfelt, 2017). Projects of different shapes and sizes are often related to innovation, whether it is a organisational change or a new product. A general working process for projects is to start to form a specification of the work frame, then plan the work, and work it out. After this the project can be summed up and all the tasks are shaped into the result of the project, which is documented and implemented in the ordinary business (Lindkvist et al., 2014).

3.3 Project organisation

A *project organisation* is used when there is an exclusive focus aimed to run a project (Pinto, 2016). The project organisation structure is known as an adaptive structure that is suitable for innovation and experience (Börnfelt, 2017). When situations appear where work tasks do not relate to a special division within the company, the project organisation is used. In these cases the work tasks are usually non-recurring (Bruzelius & Skärvad, 2011). In every project organisation there is a self-contained business unit that has a dedicated project team. To secure the competence in the team, cross functional collaborations are needed between different departments (Pinto, 2016). The fact that the employees have cross functional work

can result in problems with their dedication. In a project organisation the project manager leads the project and all the staff reports to that person.

Project organisation structure has advantages because of the designated resources that the project is given; these can lead to, e.g. improved communication, fast decisions and quick response to the markets demands. Although it does also have some weaknesses such as expensive structure. The project members could also have problems with loyalty towards their overall organisation or they could experience concerns about what happens after the project (Pinto, 2016).

3.4 Lean Production

Lean Production is an idea where the main reason is to work towards a vision or a desired future state where there is no waste. This idea includes values, principles, methods, culture, leadership and empowerment. Lean Production can be used in all branches, not only within production, therefore the idea is often called just "Lean" (Petersson et al., 2017).

The idea of Lean started in the beginning of the 20th century, but it was evaluated and promoted during the 1970s by the factory manager of Toyota, when the Toyota Production System (TPS) was created. TPS is the groundwork for Lean and the concept is about producing with the right resources, in the best way (Petersson et al., 2017). The idea of Lean has been structured by Toyota in Japan and their work is based on 14 principles.

3.4.1 The 14 Principles within Lean

To describe a Lean organisation 14 principles divided into four areas called "the 4P" are used, which stands for Philosophy, Process, People & partners and Problem solving. According to Liker (2004), the principles are :

Philosophy
1. Base your management decisions on a long-term strategy, even at the expense of short-term financial goals

Processes
2. Create continuous process flow to bring problems to the surface
3. Use pull systems to avoid overproduction
4. Level out the workload (Heijunka)
5. Build a culture of stopping to fix problems, to get quality right the first time
6. Standardized tasks are the foundation for continuous improvement and employee empowerment
7. Use visual control so no problems are hidden
8. Use only reliable, thoroughly tested technology that serves your people and processes

People and partners
9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others
10. Develop exceptional people and teams who follow your company's philosophy
11. Respect your extended network of partners and suppliers by challenging them and helping them improve

Problem solving
12. Go and see for yourself to thoroughly understand the situation
13. Make decisions slowly by consensus, thoroughly considering all options
14. Become a learning organisation through relentless reflection (Hansei) and continuous improvements (Kaizen) (Liker, 2004).

The 1st principle, and the only one within Philosophy, is "Base your management decisions on a long-term strategy, even at the expense of short-term financial goals" (Liker, 2004). The belief at Toyota is that the most important factor for success is to focus on the long-term

purpose of the business rather than on short-term results. If the focus lays on developing the business in the right direction and investing in people, products and plants, the results will come and increase in the long run (Liker, 2004). This does not mean that the short-term results should be totally ignored.

The 7th principle, within the area Processes, is about visual control, "Use visual control, so no problems are hidden" (Liker, 2004). In factories in Japan there is a great focus on the work environment, and the factories are usually very clean. At Toyota they often use a method called "5S", which is a program to eliminate waste. According to Liker (2004) these are:

1. Sort - Sort through items and keep only what is needed while disposing of what is not
2. Straighten (orderliness) - A place for everything and everything is in its place
3. Shine (cleanliness) - The cleaning process often acts as a form of inspection that exposes abnormal and pre-failure conditions that could hurt quality or cause machine failure
4. Standardise (create rules) - Develop systems and procedures to maintain and monitor the first three S's
5. Sustain (self-disciplin) - Maintaining a stabilized workplace is an ongoing process of continuous improvements. (Liker, 2004)

According to Liker (2004) there is a belief that without using the 5S process, waste accumulates over the years, which covers problems. The 5S process is not a one time work, it is a continuous process for constant improvements.

Visual control should be used for finding deviations from the standards. All employees should, by using the visual control, see how they are doing compared to the standard (Liker, 2004). Visual control can be used throughout the plant, both in the production as well as in the office environment. At Toyota they do not prefer to use information technology, such as computers, as a primary tool for the visual control, it is prefered to use physical tools such as normal papers (Liker, 2004). This can be used during the daily work, to, for example, see that all tools are in place or that the production pace is followed, as well as during projects to follow up that all milestones are fulfilled.

Liker (2004) describes the 9th principle of Lean, "Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others", as one of the most basic ones. It is about taking care of the employees that already are within the company, and using their skills. By doing this, new leaders can be found within all departments in a company instead of hiring someone with no experience of the company culture. This will, referring to Liker (2004), create a valuable understanding of the work and will also create a better work climate because the leader already knows the culture and company philosophy.

The Toyota leaders are passionate about involving those who make the value added work to improve the process, this is one of the dimensions that creates a Toyota leader. Additionally the leader needs to have a deep understanding for the work. Together these two dimensions creates a leader that involve and teach their philosophy to others (Liker, 2004).

The 10th principle according to Liker (2004) is "Develop exceptional people and teams who follow your company's philosophy". In TPS teamwork is one of the most important parts, therefore it is also an important principle in Lean. Within Toyota the teams are built to support, teach and motivate each other, although it is important to understand that the individuals do the value-added work, while teams coordinate it. Therefore individuals should not spend all their time in meetings, they should do their detailed work instead (Liker, 2004).

To be able to create these great efficient teams, Toyota requires a lot of time for the recruitment process, in order to find the right individual that would fit into a team at the company. Liker (2004) writes that excellent individuals are required to reach this level of teamwork that exists within Toyota. At the company they have the philosophy that teamwork is fundamental, therefore, individuals will do anything to accomplish their work and support their team.

The 12th principle within Lean Production according to Liker (2004) is "Go and see for yourself to thoroughly understand the situation", in this case it is based on a study made at Toyota where they highly emphasize this. At Toyota it is not accepted to rely on former experiences or reports, whether they are made by yourself or others. It is always demanded of leaders to go and see for themselves which is called *Go to Gemba*, which means go to the actual place (Liker, 2004). Go to Gemba should always be the first step in the problem-solving process.

The reason why Go to Gemba is so important at Toyota is because it gives the leader a deeper understanding of the problem, especially when it is not acceptable to trust former reports. To be a creative and innovative leader, according to Liker (2004), you need to understand all aspects of the problem. The ability to Go to Gemba is one of the traits that the greatest leaders at Toyota have in common.

3.4.2 Muri, Mura and Muda

As mentioned in the previous chapter Lean is about eliminating waste and working with continuous improvements to strive for perfection. This improvement work is done by continuously trying to eliminate: *Muri, Mura and Muda* (Petersson et al., 2015). *Muri* stands for overburdening people or equipment, which means that the amount of work done exceeds their capacity. This can result in safety and quality problems, as well as cause equipment failure and defects in the products (Liker, 2004). *Mura* stands for unevenness and variations. Having high unevenness in production means that resources for the highest demands are needed in form of people, inventory and equipment, even at times when there can be a lack of work tasks (Petersson et al., 2015). *Muda* is about non-value-added activities or waste. Muda is usually the result of Muri and Mura, because overburdening people or equipment as well as unevenness can lead to waste. Muda is divided into eight wastes usually called the "Seven plus one wastes" (Petersson et al., 2015).

3.4.2.1 Seven plus one wastes

To improve a business and increase the value-added activities, it is important within Lean to identify Muda, waste (Petersson et al., 2015). First Toyota identified seven types of non-value-adding activities. Later on, an eighth was added, therefore, they are called the "seven plus one wastes" (Liker and Meier, 2006). These wastes can be found in most types of organisations, for example within product development, production, as well as in the office. The purpose of working with these wastes is to find areas to improve and decrease the non-value-added work (Liker and Meier, 2006).

According to Liker and Meier (2006) these are the 7+1 wastes:

1. Overproduction
2. Waiting

3. Transportation or conveyance
4. Over processing or incorrect processing
5. Excess inventory
6. Unnecessary movement
7. Defects
8. Unused employee creativity (Liker and Meier, 2006)

The first waste is Overproduction which means producing more than the customer wants, either earlier or in greater quantities. Overproduction is often seen as the worst type of waste, since it can lead to increases in other wastes such as excess inventory and increased transportation (Petersson et al, 2015).

Waiting means that the time is unused because there is not possible to proceed with the work. This can be when an operator waits for a machine to finish or people waiting for someone late in a meeting. It can also be about waiting for information to be able to proceed with the work (Liker and Meier, 2006).

Moving the product from one place to another within the process or moving materials and parts between processes and storage is the waste transportation (Liker and Meier, 2006). Transportation is usually a non-value-added activity which the customer does not want to pay for, except the transportation when the complete product is sent to the customer (Petersson et al., 2015).
Over processing can be a waste in two ways. By inefficient processing, for example, unnecessary motion and producing defects, or by producing with a higher quality than the customer requires (Liker and Meier, 2006).

At Toyota, it is believed that excess inventory is a waste that hides problems within the production such as late deliveries from suppliers, defects and equipment downtime (Liker and Meier, 2006). Having excess inventory also increases the amount of products in work and the lead time through the production. A lot of capital is also found within this inventory (Petersson et al., 2015).

All movements that do not add value for the customer is seen as a waste. This can include both having to walk further distances as well as tools placed so the operator has to bend or stretch to reach them (Petersson et al., 2015).

Production of defect products leads to either waste in form of rejection or rework repairing the defective product. In the case of rejection, replacement production also needs to be performed (Liker and Meier, 2006).

Unused employee creativity is the waste that have been added after the original seven ones were defined. Today it is recognised in Lean organisations such as at Toyota. This waste is about not using and taking into account the creativity or skills of all the employees within the organisation, which means that improvements and learning opportunities can be lost (Liker and Meier, 2006).

3.5 Lessons learned

In project work it is unusual to document the insights during the project as they appear, instead it is common practice to do this at the end of every project. This can be done by a debriefing workshop for the project members, where personal responsibility and resource

allocation are the main topics. If the insights are not documented until the end of a project, knowledge and gathered experiences can be lost. A method called *Lessons Learned* is advised in the end of every project to avoid this. *Lessons Learned* is defined as " key project experiences which have a certain general business relevance for future projects. They have been validated by a project team and represent a consensus on a key insight that should be considered in future projects." (Schindler, M. Eppler, M.J. 2003). Lessons Learned are used to avoid the lost of knowledge gathered during a project, therefore, it is supposed to be used as a reference for the next project so that does not start working on the same mistake again.

3.6 Failure Mode and Effect Analysis

Failure Mode and Effect Analysis (FMEA) is a method for reliability analysis. The FMEA can either be a construction FMEA which takes place during the design and process development, or a process FMEA which is performed on existing products or processes (Bergman & Klevsjö, 2012). The purpose of an FMEA is to identify risks and problems before they occur; usually the focus is on preventing defects and increasing safety and customer satisfaction. By doing an FMEA in the product creation process, improvements can be identified earlier, when changes to the product and the process are easier and cheaper (McDermott, Mikulak and Beauregard, 2009). To get the best result of an FMEA it is important that people with the right skills are involved.

3.7 Benchmarking

Benchmarking is a method used to find opportunities for improvements by comparing the business in relation to others. There are three main types of benchmarking: internal-, rivalry- or function oriented benchmarking (Ax, Johansson and Kullvén, 2015). Internal benchmarking focuses on comparisons within the company, such as comparing different divisions or departments with the goal to find the best practise (Lindkvist et al., 2014). To perform the benchmarking the work needs to be similar in the different departments, for example, production and distribution (Ax at el., 2015). The benefit with internal benchmarking is that the information is easy to collect and a greater amount of information could be given (Lindkvist et al., 2014). Rivalry benchmarking is made by comparing the company with its competitors. Furthermore, function oriented benchmarking is also focused on the external environment, but does not necessarily look at competitors. It is focused on a company performing the best practise, which can be within a different branch (Ax et al, 2015).

3.8 Target Costing

Target costing is a method used in financial management. It starts in the product creation process with the focus on future cost reductions by working with quality, reliability and other customer requirements. One reason to work with target costing is the phenomenon *Cost Locking*. This means that 70-90% of a product costs is determined from the decisions made during the product development process, for example how the product look, production methods, material choices, etc. This means only a small amount of the product costs are possible to change when production has started (Ax et al, 2015).

3.9 Key Performance Indicators

Key Performance Indicators (KPI) is a term for describing performance measurements (Ax et al, 2015). Where performance is referring to what has been accomplished or what will be accomplished in the future. Performance measurements mean that this performance is measured in a way that the result can be compared to former or forward performances. KPIs' can be both of financial and non-financial kind (Ax et al, 2015). Usual areas for using KPIs' are: the cost, customer satisfaction, efficiency within production or the quality of the performance etc. The purpose of using KPIs' is strategy implementation and reaching goals within each KPI (Ax et al, 2015).

3.10 Design for Manufacture and Assembly

Design for Manufacture and Assembly (DFMA) refers to the theory about both *Design for Manufacture* and *Design for Assembly*. Manufacturing means the production of individual components or parts, for example machining, molding etc. Assembly refers to the joining of the manufactured parts into the complete product (Boothroyd, Dewhurst and Knight, 2002). According to Ax et al. (2015) the method is used with the purpose to reduce the production costs and the number of components.

According to Boothroyd et al. (2002) DFMA is used for three main activities:

1. As de basis for concurrent engineering studies to provide guidance to the design team in simplifying the product structure, to reduce manufacturing and assembly costs, and to quantify the improvements.
2. As a benchmarking tool to study competitors' products and quantify manufacturing and assembly difficulties.
3. As a should-cost tool to help negotiate suppliers contracts. (Boothroyd et al., 2002).

By using DFMA it is possible to shorten the product cycle time, minimise development costs and ensure a smooth transition from the development and prototype stage into production (Zulki, 2008).

3.11 Motivation

Motivation is the psychological term for the part of an individual that forms and directs the behaviour of a person towards different goals. Therefore, theories about motivation can prove why people handle different situations in different ways (Öhman, (n.d)). Motivation can be related to the work extension and its challenges each individual. One way to understand these differences between different people's motivations is the theory where people are either described by theory X or Y (Bönfeldt, 2017). Theory X describes people who do not want to work and have no purpose to lead or arrange their own work. This type of person prefers to be directed; therefore, the leader for this person need to use commands and force them to work. The theory Y is more humane where people want to work and have self control together with the drive to accomplish their goals. This type of person do usually like to take responsibilities and solve problems; therefore, they need a leadership formed of integration and individual goals.

4. CURRENT STATE

The current state is the first part of the result in this thesis work. This section contains a description of how the organisation looks, how project work is done today and the result of the interview questions about the current state.

4.1 Organisation

The company is big and complex since it is a global business, therefore, this description only includes the parts of the organisation that are relevant for this thesis work. In the description there are both information and organisation charts taken from the BMS. Only those roles and functions that are relevant for this thesis work are described in detail. All the interview respondents from the study are working within the organisations described in the following chapters.

Within Volvo there are three different units that create the core processes: Product Creation, Consumer Experience and Manufacturing & Logistics. See figure 3 below for the processes and their subprocesses. Consumer Experience has not been dealt with in this thesis work and will therefore not be further described.

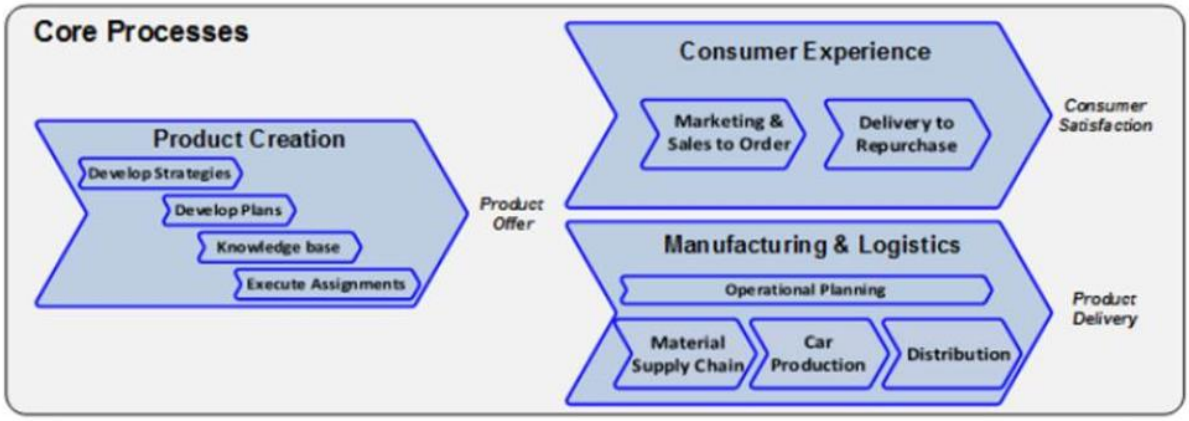

Figure 3. Core Processes of Volvo Cars according to BMS.

4.1.1 Product Creation

The Product Creation unit consists of four main processes: Develop Strategies, Develop Plans, Knowledge base and Execute Assignments. The people interviewed from the departments Strategic Product Planning and P&Q belong to this unit. The outcome of the Product Creation process is a Product Offer, which is the foundation for the work within Consumer Experience and M&L. The Product Creation process will be described further on in the Chapter 4.2.1.

4.1.2 Manufacturing and Logistics (M&L)

The purpose of the M&L unit is to fulfill the process of a new car from creation of the production plan to the delivery. This process has the objective to plan, produce and deliver cars according to the demands of the market, but also company directives such as sustainability, precision and quality. Therefore, it contains four main processes: Operational Planning, Material Supply Chain, Car Production and Distribution, as seen in figure 3 above. The Operational Planning creates the sequence of orders to secure the daily production.

Material Supply Chain is the process that secure that material is available at the right time, with the right quantity and quality, in production. Car production implicates the process to fulfill the production of cars, by producing vehicles along with the standard principles according to Volvo Cars Manufacturing System (VCMS). Distribution is the process of the transport, where cars are moved from the plant to the dealer, in accordance with the agreed final delivery point with the right lead time, precision and quality.

Within M&L there are several departments to reach the four defined processes. These departments are: IE, ME, Logistics, Maintenance, Production, Special Vehicles & Service, Business Office, and Supply Chain Management. Additionally the departments of Human Resources, Quality and Finance have an indirect responsibility to M&L, but are not a part of the organisation. From the M&L unit there have been interviews with respondents from the departments; IE, ME, Logistics, Maintenance and Production, as described in Chapter 2.1.2.

4.1.2.1 Volvo Cars Manufacturing System

Volvo Cars Manufacturing System (VCMS) is the global work method within M&L to reach customer satisfaction, operational excellence and flexibility. VCMS describes how the company should work and its core values. It is divided into five core parts: teamwork with engagement, stability through standardising, right from me, demand-driven flow and constant improvements. Working with these five areas will affect and increase the result of the QDFIPS.

4.1.3 Plant Management Team, VCT

VCT Plant and The Plant Management Team VCT belongs to the Manufacturing and Logistics unit. Within the Plant Management Team at VCT there are different roles with responsibility for different departments, see figure 4.

The Vice President of the VCT plant is responsible for the result of the plant, for example meeting the daily production goals. The Vice President is supported by the Business Administrative Assistant. IE is the link between the plant and the ME and P&Q department, to make sure the technical solutions fit into the production. The Quality department is responsible for that all products reach the right quality. Within the Operational Management Team there are all the departments belonging to the plant, which will be described in Chapter 4.1.4.

Material Planning and Logistics is the department that is responsible for all the material management and logistics flow within the plant. The purpose of Logistics includes both the planning and operational responsibility for all transport and logistics related activities of non-production material, productions parts and vehicles to the required location.

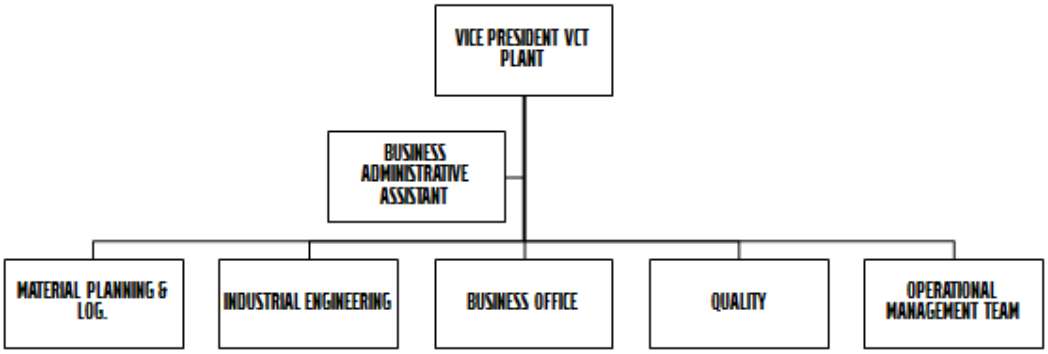

Figure 4. Organisation chart- Plant management team VCT. Modified figure from the BMS.

Together these departments have the purpose to "manufacture cars that meet the organisational targets in terms of Quality, Delivery, Finance, Improvement, People and Sustainability (QDFIPS)". Therefore, according to the BMS, their main tasks are to:

- manufacture and deliver cars according to the Manufacturing and Logistics process
- participate in and support the launch of new cars
- contribute fully to the next generation of leaders and employees by developing our leaders and employees in line with the company philosophy
- secure environmental legislation and performance

4.1.4 Operational Management Team

The Operational Management Team is a part of the Plant Management Team, described in Chapter 4.1.3, see figure 4. This team is led by the Senior Director for the VCT Plant, see figure 5 below. The Operational Management Team includes the three different shops, which are described in Chapter 1.1 but also the Special Vehicles which is the department that produces special cars, for example police cars. Maintenance is responsible for all the shops, the spare parts warehouse and coordinate maintenance processes to make the production as efficient as possible and reduce the time for stops in the plant. The Operational Management Team belongs to the department that in this thesis work is called "Production".

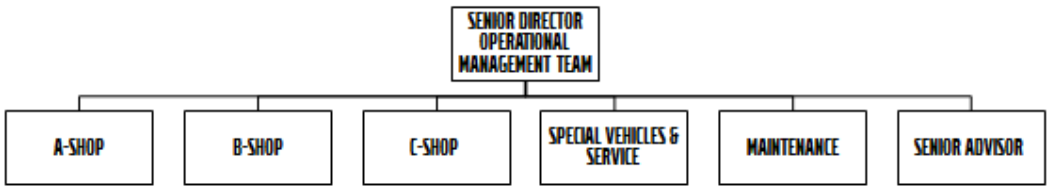

Figure 5. Organisation chart- Operational management team VCT. Modified figure from the BMS.

4.1.5 Industrial Engineering (IE)

IE is a part of the unit Manufacturing and Logistics at Volvo Cars. It is a local department that is working in the organisation for each plant. For example, as shown in figure 4, IE is a part of the Plant Management Team VCT. They are the representatives from the production to ME and therefore, the only engineers located in each plant within a local organisation. IE is working with tasks such as introduction of running changes, new car programs and the strategies for a long-term development of the plant.

The purpose of the IE organisation, due to BMS, is:

- support and help production to achieve the QDFIPS-targets
- secure flawless introduction of running changes and special vehicles
- secure flawless introduction of car programs
- be the link between ME and the Plant and secure a good cooperation
- supporting plant in its strategic development

To be able to accomplish their purpose IE's main tasks are to support the production in the line balancing both for improvements in existing processes and the introduction of new products or processes. IE also drives quality improvements for current car models and the launch of new car projects to ensure the introduction into the departments at the plant goes as flawlessly as possible. In the function description from BMS, these purposes together with the main tasks result in a large area of responsibility.

The responsibilities for IE, according to BMS, are:

- Be the Plant/Shop specialists in technical issues concerning product and process.
- Support production in their work with first line analysis when expertise is needed.
- Responsible for second line analysis (QDFIPS/DMAIC) when first line analyses has been performed by production or deviations are noticed by VRT (Variability Reduction Team) and secure this within the agreed lead time and performed tests accordingly (NA for APAC).
- During launch provide necessary input from running production.
- Actively participate in the VRT-team as a part of the BSAQ concept. Steer in new points and act as a buddy or champion to have a quick introduction (NA for APAC).
- Support production in Kaizen Workshops and other continuous improvement initiatives.
- Support Core ME in projects.
- Support Production in reaching man hour targets for operations on running models and drive productivity improvements.
- Respond on capacity investigation requests (CIR).
- Drive non-product spending projects for current models.
- Justify request (facts and figures) and introduce product and process improvement related investments.
- Responsible for layout and area council.
- Issue TPII:s.
- Handle negotiations with unions concerning questions around line balancing. If needed also initiate/negotiate new agreements with the support of labour affairs.
- Feed Lessons Learned to ME Core and ME Commodity.
- Participate in FMEA's.
- Increase commonality and share best practices by working together within Volvo Cars Group.
- Support and develop the employees so that they are able to perform their responsibilities towards their customer.
- Introduce and work with behaviours according to Aspired Lean Leadership.
- Prepare workforce readiness (NA for VCG).
- Prepare and execute pre-serie planning (NA for VCG).
- Prepare and manage approved launch budget (NA for VCG).
- Drive issue management.
- Evaluate proposed control plan, improve and handover to production (NA for VCG).
- Continues development and usages of work processes and IT tools.
- Coordinate the manning needs for plant.

- Act as home base manager for all plant related personnel working in ME (VCG).
- Responsible for plant VCMS introduction and implementation (APAC).

The IE departments are local organisations, therefore, they look different in the different plants, see figure 6, where the differences between IE at VCT and the other plants are shown. The figure aim to show that the organisations includes different functions and areas of responsibilities. For example one of the greatest differences between VCT and VCG is that in VCT Plant Launch is a part of the IE organisation and in VCG it is not. The Plant Launch departments have the same responsibilities within both the plants, no matter if they are a part of IE or not. The roles within the IE management team in the plants are not exactly the same; the organisations at VCT and VCG will be described in the following chapters.

Responsibilities areas, AS-IS SITUATION	IE VCT	IE VCG	IE VCCD	IE VCDQ	IE AELQ
Plant Launch	Y	N	Y	Y	N
VRT (VRT leader, PPE, PdT)	Y	Y	N	N	N
Process Engineering	Y	Y	Y	Y	N
OD/VCMS	N	Y	N	Y	N
Strategy - vision	Y	Y	N	N	N
Strategy – target deployment	Y	Y	N	N	N
Strategy – target mindset ("soft" mindset)	N	Y	N	N	N
Kaizen Team	N	Y (c-shop)	N	N	Y
MP&L (Logistics Engineering)	N	N	N	N	N
Special Vehicles	N	N	N	N	N
Specific funtions, AS-IS SITUATION	**IE VCT**	**IE VCG**	**IE VCCD**	**IE VCDQ**	**IE AELQ**
VRT Analysts	Y	N	N	N	N
Structure Engineers	Y	N	N	N	N
System engineer(part of process engineering in TCF)	N	N	Y	Y	N
Local Efficiency Coordinator	Y	Y	N	N	N
Layout Engineer	Y	Y	Y	Y	Y
Simulation Engineer	Y	Y	in progress	N	Y
IE OD Process Owner	Y		Y	N	Y

Figure 6. Difference between the IE organisations in different plants (Högberg, 2018).

4.1.5.1 The IE organisation at VCT

As shown in figure 7, there are several different roles within the IE organisation at VCT. The Senior Director is a part of the Plant Management Team VCT. A part of the role is to be the technical representative and responsible for the IE department and its development, both daily and long-term strategy. The work includes both financial responsibilities as well as develop the skills of the employees. All of the different roles in the organisation chart in figure 7 reports directly to the Senior Director. The Operational Development role includes work about what work methods, routines and checklists should be used. This role is shared between VCT and VCG, and works with finding mutual work methods for the two organisations to align in the same direction. There is one Senior Manager within each shop (A, B and C) at VCT; they are not directly connected to the Operational Management Team in the organisation charts, but they work alongside and share some responsibilities. The Senior Manager oversees technicians as well as process engineers, process managers and project leaders.

The Project Manager works with how the plant should work with and align its projects. The Strategy role is led by the Senior Advisor Strategy who works with the long-term strategy for the plant. The Variability Reduction Team (VRT) is a cross-functional group working with customer complaints about defective cars. They work with statistics of how many of the sold cars have defects and customers visiting a repair shop after buying their Volvo. With the use of this information they try to find solutions to improve the process to decrease the number of

defective cars. VRT is led by the VRT manager who is included in the IE management team. Plant Launch is a subdepartment within IE at VCT and the Plant Launch Director leads the Plant Launch Team as a project manager. Plant Launch ensure the plant's involvement in the launch of existing cars and new cars.

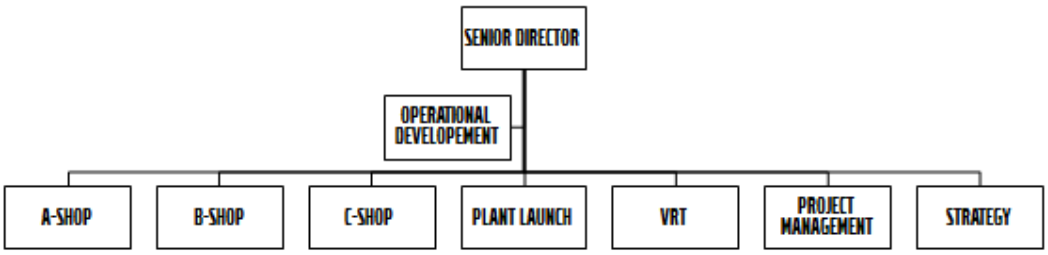

Figure 7. Organisation chart- IE at VCT. Modified figure from the BMS.

4.1.5.2 The IE organisation at VCG

The IE organisation at VCG does not have the same structure as VCT. There are different roles regarding almost all areas. There are three areas of the organisation that are the same as at VCT, these are: Senior Director, Senior Manager A-shop and Senior Manager B-shop. The C-shop is split up at VCG between three managers, and they do not have the Project Manager or Strategy roles as they do at VCT. At VCG the VRT is a part of the responsibilities for one of the Senior Managers C-shop, see figure 8 below. The other two Senior Managers C-shop are working with forward models or the process engineers. Additionally, the Plant Launch team has their own organisation in VCG, as described in figure 6 above.

At VCG the organisation has a manager for non-product projects, which means all the projects that are not related to new cars. This person has responsibilities that covers parts of the work for the Project Management role and Strategy Advisor at VCT, but there are also differences because these roles do not exist in VCG. The manager for non-product projects works in the early phases of industrialisation projects including layout or balancing for example.

At VCG there is also an Administrative Assistant in the organisation chart, although this resource is shared with other departments and works for IE approximately 25% of the time, according to the management group of IE.

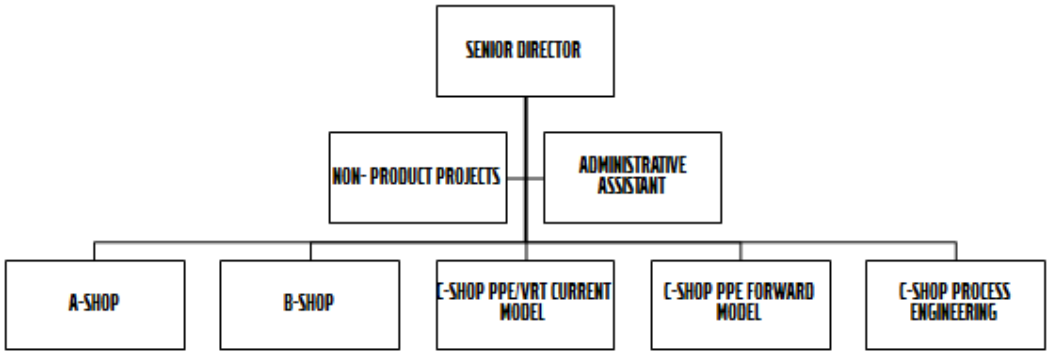

Figure 8. Organisation chart- IE at VCG. Modified figure from the BMS.

4.1.6 Manufacturing Engineering (ME)

ME is also a part of the Manufacturing and Logistics unit. The ME organisation is global and is therefore not described in the organisation charts for VCT. The ME department is responsible for the development of the manufacturing process, which is a part of the production creation process. The organisation of ME consists of three parts: Core, Commodity and Tooling & Equipment. These subdepartments works within different phases of a project. The following descriptions comes from the function descriptions in BMS.

Core ME works in the earlier phases, to define strategy and manufacturing demands. Additionally, Core ME should also implement the Lessons Learned in the concepts, likewise as they are responsible for defining manufacturing requirements for each respective vehicle program among other responsibilities. Commodity ME cooperates with Core ME for the process driven product development. They have the overall responsibility to define and implement production systems, tools, equipment and assembly instructions. Tooling & Equipment ME are involved in both car projects as well as industrial projects connected to the equipment. Therefore, they are responsible for that the tooling strategy, so it meets the targets from manufacturing. They also define, implement and verify the equipment and tools from Commodity ME.

The purpose of ME, including these three subdepartments, according to the BMS, is:

- To define prepare, launch, maintain waste free, flexible industrial systems and robust Products.
- Implement vehicle programs, change orders and engineering changes in the respective global production sites according to the targets within M&L.
- Develop, implement, introduce and maintain quality-assured, effective and standardized production systems according to targets.
- Ensure a process-driven product development with focus on effective and quality secured production and robust design/process solutions.

There are several main tasks within the ME organisation, according to the BMS, these are:

- Define and maintain technical production process strategies within the area including cross-brand development and integration.
- Securing the manufacturing requirements incl. launch within the programs and responsible to secure the gate / milestone deliveries for VCME and Volvo Cars.
- Program management of all Capacity and Replacement investments within M&L Manufacturing units.
- Define, introduce and maintain (change order) production systems and assembly instructions
- Ensure a process-driven approach in product development programs and / Product Creation Process.
- Secure and implement standardization and commonality between Volvo Cars production sites.
- Define, maintain, measure and improve Develop Manufacturing Process (DMP)
- Develop and maintain Volvo Cars Bill of Process (BOP) in cross-brand activities
- Verify product process through virtual and physical series.
- Quality assurance of all product and production problems arising during launch periods and current model manufacturing. Ensure that manufacturing feasibility problems identified during previous launches are considered in the development of forward model programs.
- Manage the development of the VCME organization and resources to meet defined targets on all locations.
- Support production sites in running production with second line problem solving tasks.

To reach the purpose of ME the organisation is divided as shown in the figure 9, where the Business Administrative Assistant and Communication Manager are supporting functions for

the Vice President. Below the Vice President there are Senior Directors for each part of the production in Stamping and Body, Body, Paint, Trim and Final, Quality, Geometry and Industrial Launch who is each responsible for their department. The Senior Directors for each part have a global responsibility, which means that they have responsible for e.g. all body shops at every plant in the world.

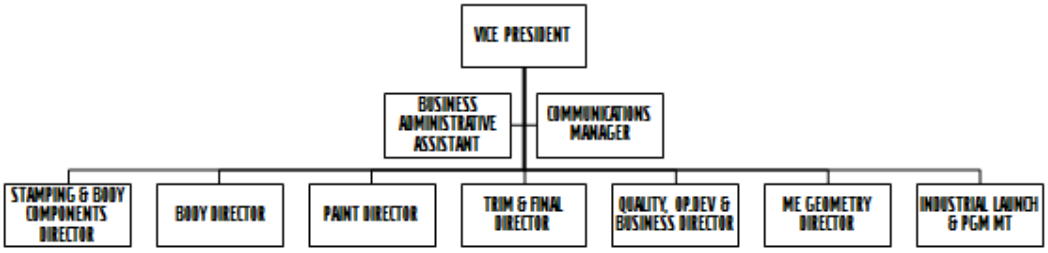

Figure 9. Organisation chart- Manufacturing Engineering. Modified figure from the BMS.

4.2 Project work

During a new project all the different departments are involved in different phases of the project. Volvo Product Development System (VPDS) is described below, including when the different departments gets involved during a project.

4.2.1 Volvo Product Development System (VPDS)

For a new car project Volvo uses *Volvo Product Development System (VPDS)*, which describes the cross-functional process of developing vehicles on time with the right quality. In figure 10 below a simplified version of the manufacturing deliverables in VPDS is described, showing what is relevant for this thesis work, from the strategy phase to the industrialisation phase. The complete VPDS logic can be found in the BMS and on an internal Sharepoint site. The logic consists of different milestones or gates which describe different deliverables during the project.

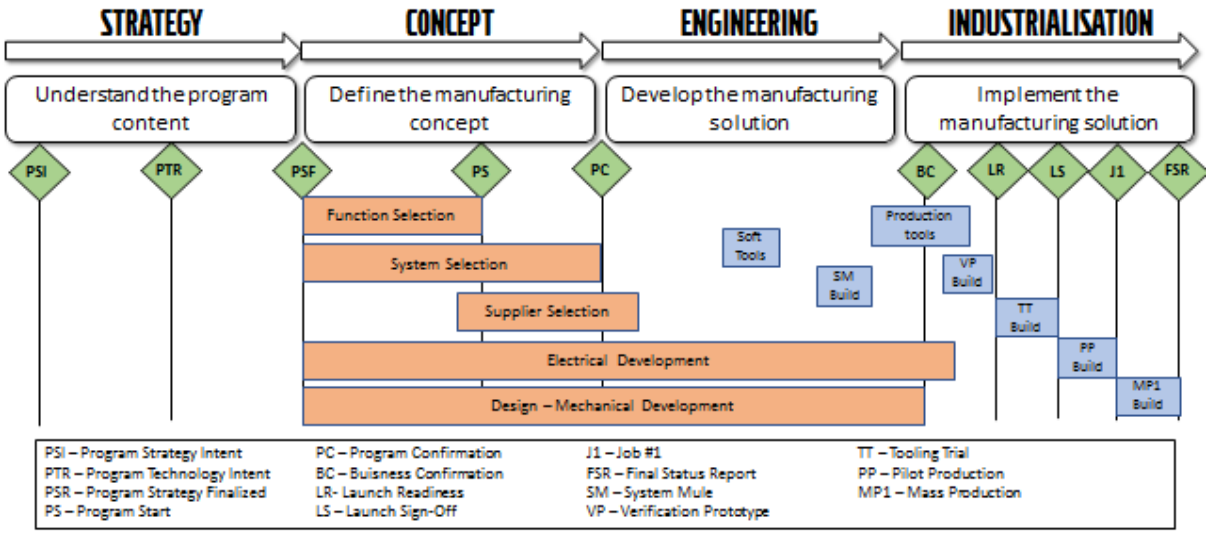

Figure 10. Overview over Manufacturing Preparation in Volvo Product Development System (VPDS). Modified figure from the BMS.

4.2.1.1 Strategy Phase

Looking at VPDS from a manufacturing perspective, the Strategy Phase is about working with manufacturing constraints, cost estimates and plant scenarios, such as an ideal future plant. The main work during this phase is done by the Strategic Product Planning department. The gates within this phase are Program Strategy Intent (PSI) and Program Technology Request (PTR), which focus on getting approval for the strategic intent and the Product Cycle-plan. These gates also include defining the product for dimensioning the base technology. The gap between businesses such as price and volume is also defined. Finally, the Strategy Phase ends with Program Strategy Finalized (PSF) when resolution of strategic issues should be approved and a prerequisite for the Concept Phase should be started. During this phase all the departments works parallel with their strategy.

4.2.1.2 Concept Phase

The Concept Phase is about defining the manufacturing concept. Here the department P&Q starts to work with function and system selection, while the electrical and mechanical development starts. Later on in the process, the Procurement department gets involved by starting the supplier selection. This part of VPDS involves milestones such as Program Start (PS) and Program Confirmation (PC). This is where prerequisites, mission, targets and program finance are set and the program is approved. At this milestone the program gets its remaining part of the financing and it is assure that all chosen function and system solutions are compatible. During the Concept Phase, the ME department begins its involvement.

4.2.1.3 Engineering Phase

After the PC milestone, the Engineering Phase starts where the manufacturing solution is developed. The main work during this phase is completed by ME Core and Commodity. Here the electrical and mechanical development continues and production of soft tools, to build prototypes, are started. This phase also includes System Mule (SM) which means that different areas of components are tested, without the complete vehicle. At the end of the Engineering Phase production tools are starting to be formed by ME.

4.2.1.4 Industrialisation Phase

The Industrialisation Phase has the purpose of implementing the manufacturing solution. Here the P&Q department should step back while the IE and Production departments get more involved into the project and work together with ME. Even if P&Q is supposed to step back in this phase, they are still working with continuous improvements. The first milestone in the Industrialisation Phase is Business Confirmation (BC) which includes giving a total business update to the Product Board where financing and targets are reconfirmed. At this point, commercial plans are decided and a detailed launch plan is confirmed together with a management summary. During Launch Readiness (LR), the complete vehicle attribute status is reviewed with the Product Board who signs off that the industrial system is ready to start their launch activities for the program. The detailed Industrial Launch Plan is decided and an approval to build the Tooling Trial (TT) is confirmed. The milestone Launch Sign-Off (LS) includes deciding the start of Pilot Production (PP) and conditions for selling the vehicles to customers, for example price and content per market. The next step is to start the Mass Production (MP1) of the car during “Job #1” (J1) where it is confirmed that all prerequisites

are ready for production. Vehicles for external customers can be produced and the markets are ready to receive and sell the vehicles. The project ends in Final Status Report (FSR) which occurs 90 days after MP1. During FSR, Lessons Learned are documented to make changes in guidelines, routines, the cycle-plan and the VPDS process. It is confirmed that all tasks are finished or transferred and the program is closed.

4.3 Result of the interviews

The interviews done during this thesis work have been with people working within all the four phases of VPDS (Strategy, Concept, Engineering and Industrialisation), but most of them works within the Industrialisation Phase. Figure 11 has been constructed considering the result of the interviews and observations made during this thesis work. It shows an overview over ME's work during the three phases they are involved in (Concept, Engineering and Industrialisation). The figure also shows where in the development process the investment decision is taken. In the figure, the Consumer experience, P&Q, Procurement, Maintenance and Logistics departments are included since these are some of the departments that work together with ME during some parts of a project. In this figure IE is connected to the different plants since they are local departments. To explain the current situation with IE's involvement, the arrows have been coloured green to indicate where IE is involved today and red where they are not.

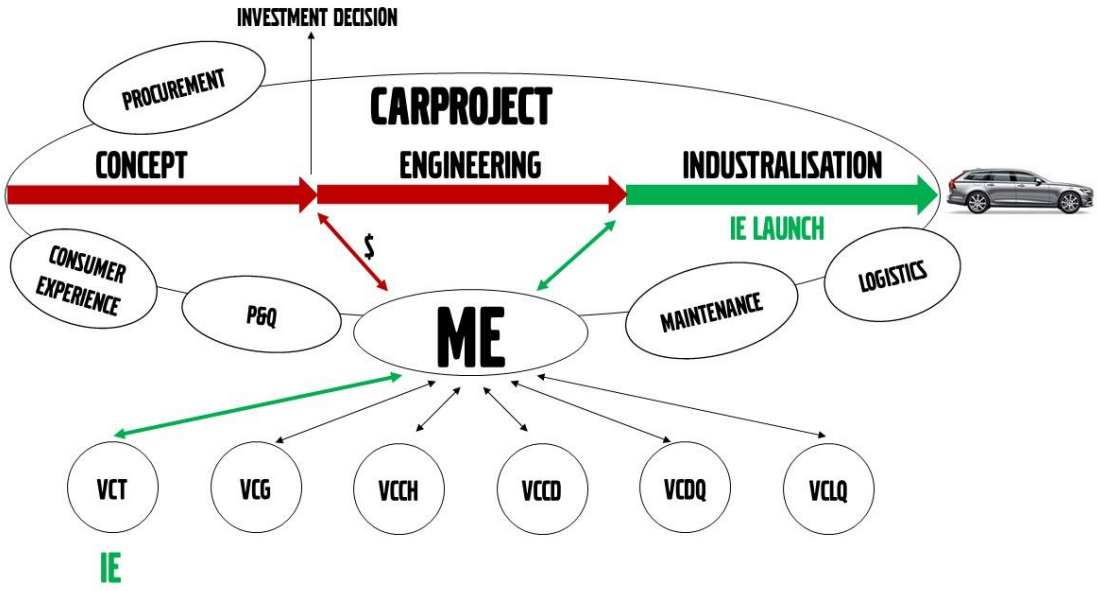

Figure 11. Current state result from interviews. The writers' own original figure.

When IE gets involved after the engineering phase it becomes difficult to give input and request changes, to make the product fit better into the production plant. This is because the investment decision has already been decided and possible changes would be very expensive, which is one of the reasons why changes often cannnot be made. When this situation occurs compromise solutions are often made, where the solution is not perfect either for the production plant or the economy of Volvo.

These compromise solutions can result in expensive adjustments. For example, when the solution from the construction phase does not reach the ergonomic requirements, the production plant can solve it by rearranging their personnel so that a work task is made by two employees instead of one, which is more expensive. Additionally, these compromise solutions can appear in industrial projects, where big rebuildings can be avoided and solved by temporary stations in the plant where there is room, and not where they should be to make the production efficient. By making installations not in line with the production flow it can lead to waste in the form of excess transportation, both of the product and materials. If IE was involved earlier with the plants requirements, some of these compromise solutions could be avoided. This is in concurrence with the theory about Target Costing described in Chapter 3.8. A large part of the costs is determined during the early phases of the creation process and cannot be affected in a greater extent afterwards. By working more with Design for Manufacture and Assembly, described in Chapter 3.10, the right decisions can be taken from the beginning, minimising the total cost.

4.3.1 Communication between the departments

This section includes a description of how the different departments collaborate and communicate with each other.

4.3.1.1 Departments working within silos

A common description from the interviews both at VCT and VCG were that the different departments at Volvo often work within silos. This means they work a lot within their own departments and are involved during different times of the project so they do not always have the best communication. This can sometimes lead to two persons who might be working on the same thing. Figure 12 below shows an example of each department working within its own silo and not together with the others. This does not mean that the departments never interfere or speak to each other, but according to the interviews it is an area for improvements. The arrows in the figure describe the information flow, which is mainly within the own departments and just in small amounts between the departments.

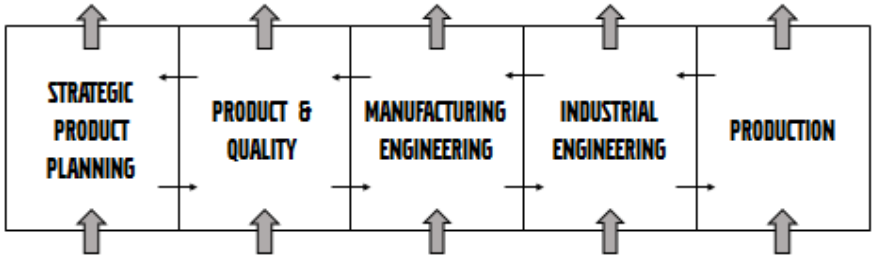

Figure 12. Example of how the departments works within silos. The writers' own original figure.

4.3.1.2 Requirements from IE to ME

During some interviews it was mentioned that there is a lack of formal way of communicating requirements from IE to ME. It was perceived as "engineers talking to and handshaking with other engineers", which results in differences depending on who this engineer is. This perception was found in the interviews with both IE and ME, that the communication of requirements depends on the personal relationship and talking to the right person. Different people have different personalities and therefore have different responsiveness to adapting

changes, which could be explained by theory X and Y described in Chapter 3.11. This can lead to big differences in how requirements are communicated and received, both during different projects and plants.

4.3.1.3 Requirements from ME to P&Q

According to the interviews, there is no formal way of communicating requirements from the plant and IE to ME. ME in turn communicates manufacturing requirements to P&Q through a system called System Weaver. This system is not open to everyone working at Volvo, special access is needed. Many of the people working within the plant and IE seems to not know that this process of communicating requirements exists. During the interviews with P&Q the perception was given that they believe they get all the requirements and that there is no problem with the communication of them. The problem here, according to the interviews, seemed to be that Strategic Product Planning and P&Q did not know what IE is and that they thought that ME represented the whole manufacturing process.

4.3.1.4 Active communication

According to the interviews it seems like the earliest IE gets involved today is at the virtual build event, where the car is built step by step in a computer. The general consensus from the interviews was that even if IE was included during this event they see it as additional information, to see what is coming to the plant, rather than an opportunity for questioning. It seems usual that the plant starts to express concern and first question the production solutions when they are installed into the plant. At this stage it is too late and expensive to make any greater changes. The same problem was described with the work of an ideal plant. ME has been working with the vision of the ideal plant for a longer time, and IE has been included in meetings about this, where they have agreed and approved the layout from ME. Now when the plant starts to work with their Vision Plant, they realise they are not thinking in the same way as ME. The meetings with ME has probably been seen as additional information, and no one has questioned the solutions.

A description of the problem, according to the interviews, were that sometimes the production solutions from ME work theoretically but do not work practically within the production plant. This problem can be described as over engineering. Later, when the installation is to be made, it is realised that it is not possible as planned and last minute changes have to be made. This is an indication that the work method Go to Gemba, which is described in Chapter 3.4.1, has not been fully used, when ME could have visited the plant and taken the real situation into account in earlier phases to avoid these problems.

4.3.1.5 Collaboration between the plants

ME is a global organisation, which works with all the six plants. This mean when they are working with a new product, they have requirements or wishes from all these six plants. Sometimes it can be hard for ME to fully understand these requirements and secure them, if one plant asks for one thing and the other plant asks for the opposite. It was mentioned in the interviews that there are improvements for both IE and Production to increase the collaboration with the other shops and plants. This can be done through A-shop, B-shop and C-shop as well as with the other plants, to point out problems and set requirements together. Since all the plants are different and built during different time periods, there might sometimes be different requirements depending on the plant.

4.3.1.6 Lessons learned at Volvo

One way of mediating requirements is through the process Lessons Learned, which is written after a project to address problems. The general Lessons Learned process is described in Chapter 3.5. In the Lessons Learned an analysis over the problem is done and the Lessons Learned is sent to ME from either Production or IE, to avoid the same problems in the future. This method came up during the majority of the interviews with both IE and ME. During all the interviews the perception was that this process is not ideal. IE expressed that even if Lessons Learned is done, they receive the same problems again. During one of the interviews with a member from ME it was said that ME uses the Lessons Learned. However, sometimes it contains too little information for ME to understand the problem, which means it does not get prioritised. According to the interviews, it seems like there is too little communication between ME, IE and Production. For example, some changes might not be possible even if the plant requests it, but they do not get information about why it cannot be changed and instead think that ME did not listen to them. This usually can occur with so called carry-over problems, the cars are built on the same platform, which means some constructions are the same through all the models, which makes it harder to change them.

4.3.1.7 Information flow

A problem described from the interviews both with IE and Logistics was that even if information is requested it is often hard to get the information in time. Logistics explained this problem that occurs because they are the last department in the sequence before production is started. For example, they cannot start their work before IE has completed the work with balancing or when Procurement has decided everything together with the supplier. This means they cannot plan their logistic flows until they know where all the material should be and how the packaging of the new material will look. Usually this work is finished just some weeks before production is started. IE in turn cannot complete the balancing of the stations if they do not have sufficient information from ME. This can be described by the waste Waiting, described in Chapter 3.4.2, meaning that the departments cannot do their work before they have enough information from the preceding department. The general thought from the interviews was that for IE to be involved earlier, all the departments needs to move their focus earlier in the process to be able to give the succedent departments the needed information.

4.3.2 Project meetings

Today there are several formal meeting points between the different departments during different stages of the project. This thesis work will not look at all the meetings that occur during a project, rather the ones that came up most frequently during the interviews. These meetings are also a forum for communicating the requirements from the plants to ME.

4.3.2.1 Control Tower

A cross functional meeting called Control Tower is held with members from the departments ME, Logistics, Plant Launch, Maintenance, IE, Production, P&Q, Procurement and IT. The purpose of this meeting is to meet and review plans and status of the project during the launch, in order to identify issues as early as possible to be able to work with improvements. The meetings are held on a local shop level, which means there is one meeting for A-shop, B-shop and C-shop respectively. The meeting structure with Control Tower is held on a weekly basis in the industrialisation phase between Machine Try Out (MTO) until Final Status Report (FSR), described in Chapter 4.2.1. The meeting is held in a specific room every week. In this

room everything is printed out on papers and put on the walls, to easily get an overview. Here the Masterplan is followed up and that all the departments have reached their goals. This method is in concurrence with the Lean theory and the 7th principle "Use visual control so no problems are hidden", that is mentioned in Chapter 3.4.2. By having everything printed out it is easy for everyone to see how it is going and to follow up. This meeting structure is quite new and has not been used for a long period of time, but all of the interviewed people who talked about Control Tower had a positive attitude towards this meeting.

4.3.2.2 Global Technical and Project Control (TPC)

Global Technical and Project Control (TPC) are global cross functional meetings initiated by ME. These are held on global shop level, one for A-shop, B-shop and C-shop respectively, which means that the meetings are for all the plants and not only the shops within for example, VCT. People from the different ME sub departments are invited to these meetings as well as IE and Plant Management, sometimes others are invited depending on the agenda. The aim of these meetings is to prioritise within projects and budget frames as well as making decisions regarding technical, strategic and project issues. The TPC meetings are held on a weekly basis during the whole project.

According to the interviews, both IE and Production do not always use the opportunity to attend these meetings even if they are invited. These meetings do not get prioritised since the daily production easily takes over and the shops' main focus is not in early phases. When IE and Production do not attend these meetings, all the information does not reach the plant, which makes it harder to affect decisions made in earlier phases. It is also important that the right people are included in these meetings, since it is important to reflect over the content and what it actually means.

4.3.2.3 FMEA at Volvo

Both Design and Process FMEA are used at Volvo, the method FMEA is described in Chapter 3.6. During the FMEA, Process Engineers from IE are invited, this is usually the first time that IE gets involved in the project. In FMEA an Initial Risk Assessment (Risk Discovery) is performed to identify high level risks early in the project. The FMEA should be performed early in the Product Creation Process in order to prevent issues for both product and process. Different departments are responsible for different types of FMEAs, the mandatory participants for the Design FMEA are P&Q and ME. For Process FMEA P&Q, ME and Production are mandatory participants. According to the interviews the FMEAs are performed at different times for different processes or designs, an estimated time when the FMEA occurs, is approximately 1,5 years before the Start of Production (SOP), viewed in figure 10.

For the FMEA to work, the right people with the right skills needs to be involved, some of the interviews showed that this is not always the case. For example, one person described that sometimes when a problem occurs in the plant, they go back and look at the FMEA to see if the risk was included from the beginning. Several times they have found an incomplete FMEA where neither Production or IE have been included. According to the interview, the explanation for this usually is that IE and Production were asked to be included but did not prioritise it.

4.3.3 Benchmarking Gent

The result of the benchmarking study made at the VCG will be described as its own chapter, separate from VCT, to declare the differences and similarities between the plants.

4.3.3.1 Current state at VCG

The organisation of IE at VCG is not the same as at VCT, as described in Chapter 4.1.5. It is not only the organisation structures that are different, but also the focus and the competence within the teams are different. At VCG the IE organisation is more focused on the daily running production and they support Plant Launch and ME to a larger extent than at VCT. The reason why IE at VCG supports ME more than IE at VCT is because ME is a global organisation, which is located in the same city as VCT. Due to the distances, IE does parts of ME's work at VCG between the new car projects.

Because of the focus on daily production, the IE organisation at VCG has not worked with Early Involvement in the same way as VCT. At VCG they talk more about it in a theoretical way, how it could be done, instead of how it should be done and by who.

4.3.3.2 Project meetings

VCG has the same meeting structures as VCT, see Chapter 4.3.2. In addition to these meetings there is also a new meeting structure for early involvement at VCG, called the Logic meeting.

4.3.3.2.1 Logic meeting

The Logic meeting is an initiative to involve the right people in an earlier phase of new car projects. In this meeting there are attendants from several departments, for example, IE, ME, Production and Logistics. The main purpose of this meeting is to control manufacturing projects in a successful way by having an agreed upon plan that supports the deliveries and the cross-functional connections.

Today at VCG, there is a Logic plan for the A-shop and one for the C-shop. The main purpose of the Logic plans is to describe the delivery of the complete shops in car projects. The Logic plans are cross-functional and describe all the activities and deliverables in the integration event Logic meeting. These Logic meetings are held separately in each shop with the same purpose but different deliverables. The first Logic meeting is held before the PS in the concept phase, described in figure 10, to visualise the defined plant concept and align the program content. After this, there are three more Logic meetings held during each project, with the aim to confirm the plant solution before implementation of the program. The Logic meetings are held in earlier phases and are changed in later phases to the Control Tower, which is described in Chapter 4.3.2.1.

4.3.3.3 Result of the interviews

Since the interviews at VCG were only performed with the Management Group of IE and Plant Launch, and no other departments, the result has a narrower perspective than at VCT. From the interviews, the most common part of the description of the current state at VCG was that there is no formal work method to communicate requirements from IE to ME. They also mentioned in the Management Group of IE that there is already too much work in the daily production to be able to work with Early Involvement. All of the persons who were

interviewed mentioned that they, in some way, think that IE should be involved earlier in new car projects, even if all of them did not think it is a problem at the moment. Although, they could all agree that it would improve their work in the future if IE could be involved earlier.

In the interviews the Logic meetings were also presented as a step in the direction towards Early Involvement. These meetings create a platform with employees from all the departments who are involved in the early phases of a project. These meetings give IE the possibility to be involved and discover unsuitable solutions earlier.

For the questions about resources and organisational structure, the most common answer was that they in some way need more resources or employees with more defined responsibilities. There were some different answers about the organisational structure. One common response to this question was that earlier at VCG they had a standard in which all white collar employees were placed within the same building and categorised by their responsibilities. By this structure they found it easier to communicate with the right person, because it was easy to just go there and ask, instead of booking a meeting or call. Therefore, according to some interviews with the IE Management Group, some would like to have that standard back to save time and be able to prioritise the work with Early Involvement instead of multiple meetings.

4.3.4 Benchmarking in Skövde

The organisation at VCES is different from both VCT and VCG. At VCES they do not have an IE department, instead they have a bigger ME department that covers parts of IE's work. The work of ME is divided into three parts: Research & Technology, Manufacturing Preparation and Manufacturing Realization. The interviewed stakeholder belongs to Manufacturing Realization, which works in between Manufacturing Preparation and Production. Some of their work is similar to and can be compared to IE's work at VCT and VCG. This part of the organisation is a project organisation that only works within projects.

At VCES they also talk about Early Involvement. According to the interview, Manufacturing Realization has a lot of work to do compared to the number of resources, resulting in insources from Manufacturing Preparation. When employees from another department are involved in later phases, their work can be seen as sort of extra work. These employees may feel that they should be finished and therefore, want to move on as soon as possible. They may also want to go back to their own department and work on a new project. Rather when employees from the later phases get involved earlier a greater ownership could be taken by them. This can be explained by the shift of responsibility later in the work, therefore this work will be seen as preparation for their own following work.

The M&L Management Group wants, as mentioned in the background, the plants to take a greater ownership and responsibility over their own development. At VCES there is a disadvantage discovered that the plants might develop in different directions if they get to decide more by themselves. According to the interview, it is important that in the production of the engine, the production plants look the same and for example, has the same requirements. Today a link is missing between the plants that could work more with the long-term strategy, and the plants alignment. The power system production of engines is located in VCES and VCEZ, which are just two plants compared to the six car production plants. This means that the car production plants could experience the same kind of problem.

5. DESIRED FUTURE STATE

The desired future state is a description of how the company wishes to work in the future. It contains the parts: Early Involvement and result of the interviews.

5.1 Early Involvement

As mentioned in the problem definition, in Chapter 1.2, IE has chosen four focus areas to work within their long-term strategy, where Early Involvement is one of them, see figure 13. To be able to focus on Early Involvement together with Leadership, Competence & People and VCMS Execution, VCT have decided to work with the subjects mentioned in figure 13. The subjects mentioned are founded by the Senior Advisor Strategy together with the Plant Management Team VCT. These subjects are the employer of choice, learning leadership, engagement, improved speed, basic skill training, visualisation, problem solving, ownership and standardised work. According to this long-term strategy that IE has developed, VCT would become a world class leader in launching product and process, operational performance and driving the future vision. This would make VCT the obvious choice for car manufacturing, which is the vision of this long-term strategy.

Figure 13. Long term strategy of Volvo Cars VCT (Högberg, 2018).

Within Early Involvement, according to the strategy work at VCT, there are some work areas defined: High hurts, Role descriptions, Input in car projects and investments, Variants, Plant Vision, FMEA, Lesson Learned and Balancing agreements. In this thesis work not all of these work areas have been mentioned in the interviews, therefore they will not be discussed. The ones that correspond with this review are: Role descriptions, Input in car projects and investments, Plant Vision, FMEA and Lessons Learned. Therefore, the focus of this desired future state will be on these relevant areas.

The comprehensive idea with Early Involvement for IE is to be involved earlier, in order to be aware of what is going on in the creation process of new cars and what is about to come next. Awareness of the ongoing creation process will allow IE to be able to affect coming products and production solutions. By doing this, IE does not want to take responsibility for the new car projects earlier, but to be involved and secure that their requirements are fulfilled. To be able to do this, some focus needs to be removed from the daily production and moved towards the middle of: the long-term strategy, early car projects, continuous improvements and the daily production, see figure 14 below.

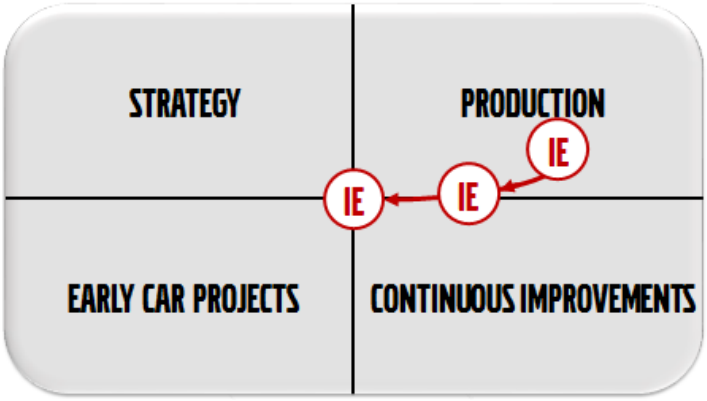

Figure 14. The focus of IE today and where the focus should be in the future. The writers' own original figure.

The focus can be removed by rewriting role descriptions or changing some of the responsibilities from IE to Production. According to the interviews, a large part of the work that IE does today, can also be done by Production, such as working with the daily improvements. By working more with VCMS, described in Chapter 4.1.2.1, within production and applying more focus on, for example, self-driven teams and continuous improvements, the teams can take a larger responsibility for the running production. This would leave more time and resources for the leaders within Production and for IE to move their focus towards the other three parts in figure 14. The work within strategy would mean more time for the long-term strategy including for example: strategic plans, the Vision Plant and the Guidelines. To work more with early car projects would mean to get involved earlier in the development process, for example by improving the teamwork together with ME by active involvement in meetings that ME invites IE to. The continuous improvement would be in areas such as daily work tasks and the preconditions for strategy work, like Early Involvement.

If IE can be involved in new car projects at an earlier phase they will also be able to unburden Plant Launch from some of their responsibilities in the early phases. Then Plant Launch could instead focus on training the employees in the production to build the new car models, regardless if Plant Launch is a part of the IE organisation or not.

The work with Early Involvement has already started and is ongoing. The plant at VCT have started to work with a Vision Plant and Guidelines. These will be described in the following chapters.

5.1.1 Vision Plant

The departments within the plant needs to agree on what they want, to be able to work more strategically and take a greater ownership. If IE is involved earlier they need to have one united voice, to be able to improve their communication of requirements to ME. Previously ME has had the responsibility to develop an ideal plant. Now IE and Production are working on their own Vision Plant for the first time. This is to work towards the ideal plant but also consider the current state as a starting point, which is done at both VCT and VCG. This work

also includes a technical Master Plan, including what changes are planned every year, to eventually reach the Vision Plant. The Vision Plant should be considered every time a change within the plant is made, to make sure that every change is in line with it. By doing this work, it should be secured that the number of compromise solutions are minimised. For example, when a new installation is about to be made it should not be placed just where there happens to be an empty spot potentially creating an inefficient flow, but in a planned place, in line with the Vision Plant.

Changing the focus from what is the cheapest production solution to what is the best in order to reach the Vision Plant, can also reduce costs in the long run. This could be done by, for example, increasing ergonomics so less personnel is needed, increasing the flow efficiency as well as decreasing lead times. Another idea to reduce the costs is to combine the financing for a new car project and industrial projects, in order to more easily reach the Vision Plant. This is in line with the first principle within Lean Production, described in Chapter 3.4.1, "Base your management decisions on a long-term strategy, even at the expense of short-term financial goals". In every decision working towards the Vision Plant the organisation is more likely to improve their KPIs, described in Chapter 3.9, over time.

5.1.2 Guidelines

When IE is talking about communicating and setting requirements, it is not about checklists, but more about creating a mutual attitude. The Senior Advisor Strategy at VCT has been working with the VCT guidelines together with the Senior Director IE at VCT, see figure 15 below. Whenever a new decision is taken it should be questioned if it is in line with the guidelines. The guidelines are divided into three areas: Design Around the Operator, Walk the Talk and Simplify Logistic Flows. Design Around the Operator is about the production, where Muri, Mura and Muda should be reduced. By challenging P&Q and ME to reduce variant complexity and not accept complicated solutions or poor ergonomics it will be possible to increase the efficiency of the plant as well as the working conditions for the operator. Isolated islands, where operators are not being used efficiently, should be reduced and running lines should be implemented in the B-shop. Walk the Talk is about being a role model and minimising compromises, by following Bill of Process and avoiding new additional buildings. Simplify Logistic Flows is about working more towards Logistics and making more efficient logistic flows. This can be done by working more with flexibility to meet volume fluctuation by working more with one touch handling. The goal is less storage and inbounds of larger components should be closer to the point of use. These guidelines should be used to increase the efficiency of the plant and to reach the Plant Performance goal (PP20-goal), which is a goal of how the KPIs should look in the year 2020.

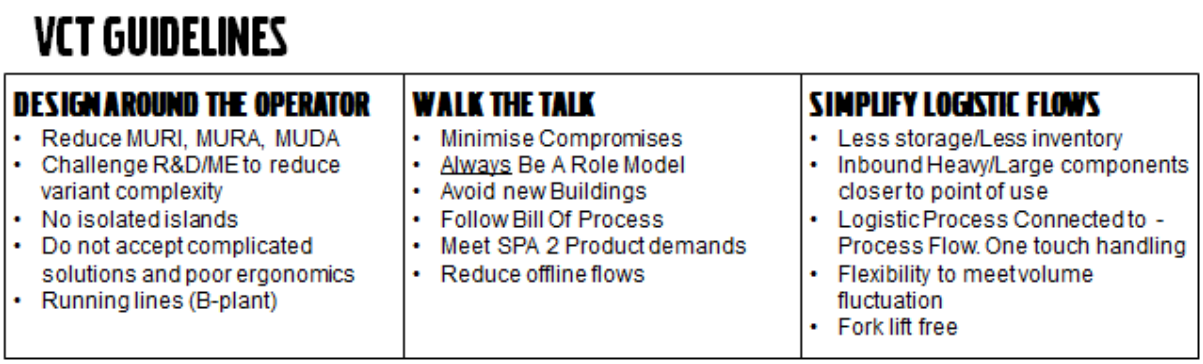

Figure 15. VCT Guidelines within the areas Design Around the Operator, Walk the Talk and Simplify Logistic Flows (Mårtensson, 2018).

VCG is trying to work in the same direction but has not come as far as VCT with their strategy work or work with guidelines since they do not have the same roles as VCT. The goal is to align the plants more in order to be able to communicate more cohesive requirements to the global departments such as ME and P&Q.

5.2 Result of the interviews

As mentioned in Chapter 1.1, IE needs to be involved earlier in new projects to be able to affect the product and process more. Figure 16 below, shows the ideal way of IE's involvement by the green arrows. This means that they would be involved in the Concept phase, before the investment decision is made. This involvement would not mean that IE gets responsibility for the project earlier, but that they would be informed and included earlier with the possibility to discover problems in a phase where they can still be corrected. By discovering these problems earlier, compromise solutions due to construction can be avoided.

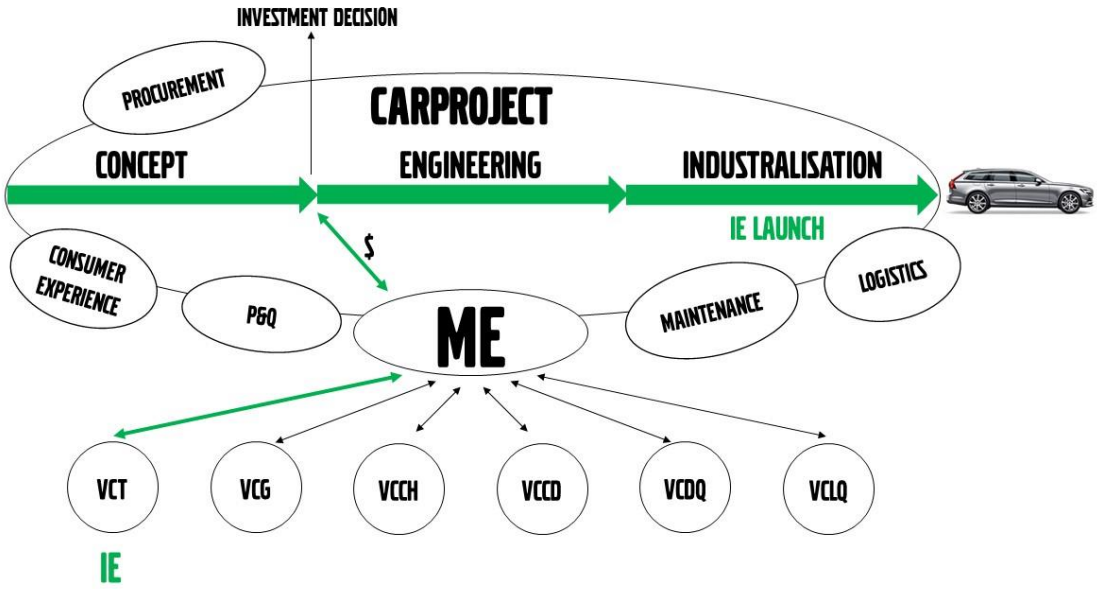

Figure 16. The ideal way of IEs involvement, according to the result of the interviews. The writers' own original figure.

According to the interviews made in this thesis work, everyone can agree that IE needs to be involved earlier in new projects. The difficulty is to know what it means and how it can be done. For the questions about how the respondents want to work in the desired future state, there were some common answers and some differences between them. Since the vision of IE is to align their work methods even if the organisations are local, these results will be presented as the same future state for both VCT and VCG.

5.2.1 Communication between the departments

Overall the problem with the communication between the departments could be improved by applying a process thinking, all the way from the creation stage to the production of the product. By doing this a "customer" and "supplier" mindset would be useful to secure that the

requirements set from the “customer” is accomplished by the “supplier”. This mindset was mentioned during the interviews both at VCT and VCG, where the employees at IE implied that ME, for example, needs to request the demands from IE. One way for this communication could be the Lessons Learned process, described in Chapter 3.5. By having a process thinking mindset the communication between the departments should improve thus decreasing misunderstandings between the departments. An important part of this work is to change the mindset of the different departments to be able to break the “silos” mentioned in Chapter 4.3.1.1. The information should flow more between the departments, as shown by the arrows in figure 17. This collaboration could create more natural communication channels in the daily work.

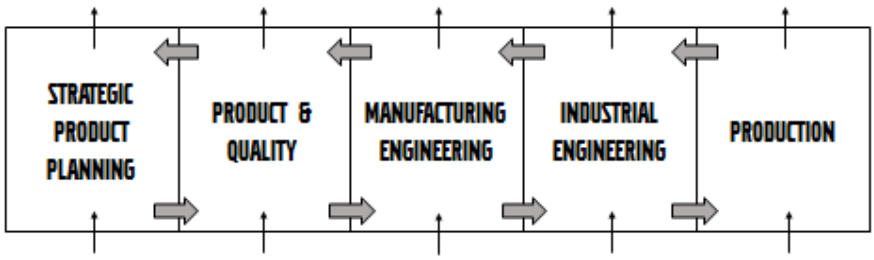

Figure 17. An example of how the departments can use an overlap work process. The writers’ own original figure.

Another part of the communication, that is a common problem overall at Volvo, according to the interviews, is to book too many meetings for every small discussion. This is a problem that also could be solved by improving the communication, and by that, save time for work tasks other than meetings. When meetings are needed it is important to secure that the right persons with the right skills are attending the meeting. An example where it is important to have the right attendants is at the FMEA. At the FMEA important discussions are held and decisions to sign off basic plant requirements are made. Additionally, having the right people with the right skills at the meetings helps to secure the requirements of the departments.

5.2.2 Project meetings

In the desired future state of Early Involvement both VCT and VCG want to use the Logic meetings as a way to involve IE in an earlier phase. This could be done by implementing the Logic meetings into all of the three different shops. By using these meetings regularly in all new projects, an agreed plan that supports the deliveries of the project and the cross-functional connections should be improved. When IE and all the involved departments participate in project meetings in this early phase, the requirements can be communicated, and problems can be discovered before it is too late to change them. Along with the development of the project, the Logic meetings have the purpose to follow up the process until the project is introduced to the plant.

Beyond the Logic meetings, a workshop for Lessons Learned was mentioned in the interviews as a way to work with requirements. By having a workshop where the departments meet physically, the requirements can more easily be secured to reach the “supplier” and also increase the understanding for the requirement. As mentioned in the Current state it is sometimes crucial for the requirement to be fulfilled, so that it can be understood by all departments.

6. GAP ANALYSIS

The following gap analysis will include both IE at VCT and VCG, as well as some references to the benchmarking with ME at VCES, to find the best work methods.

6.1 Analysis of the interview data

The analysis of the interview data was made by the method described in Chapter 2.3 and resulted in three key areas: Information, Organisation and Focus, with subcategories, see figure 18.

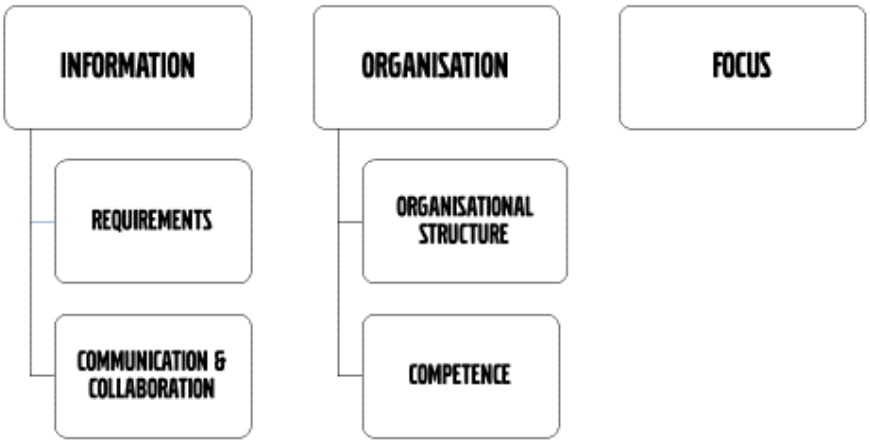

Figure 18. The three key areas and their subcategories of the data analysis. The writers' own original figure.

The first key area Information included all interview data that contained any problems related to Communication & Collaboration and Requirements. Within Requirements there were also two subcategories: FMEA and Lessons Learned. Examples of subjects that were analysed within these areas were communication problems like the transport of information from one department to another, different meeting structures and other standards that are missing, but also areas where the requirements do not reach their purpose. In the interview data it was found that requirements are mainly stated through the work methods, FMEA and Lessons Learned; therefore, they were set as a second subcategory within Requirements.

Organisation was the second key area which was categorised into Organisational Structure and Competence. Organisational Structure included subjects such as role descriptions and the organisation charts. Competence included having employees with the right skills at the right position. This subcategory also included who in the organisations that is supposed to take part in different meetings and the lack of competence to work in early phases.

Focus was the third and last key area, where subjects like focus at the daily production and not at strategy was mentioned as a problem together with the lack of taking responsibility and ownership.

From these three key areas, with their subcategories, the two specialised areas Information and Organisation were chosen for further analysis, with the area Focus as a background topic to enforce the long-term strategy. The reason why these areas were chosen to analyse, was because IE is involved too late in the process today, due to the fact that the focus within the

organisation centres too heavily on the daily running production. To be able to move the focus from “here and now” and the everyday production, an organisational reform or a structure change is needed together with distinct communication channels for information return between the different departments within the projects.

6.2 Specialised areas

From this gap analysis the specialised areas Information and Organisation were chosen to analyse further. This analysis will result in recommendations to the company to decrease the gap between the current state and the desired future state.

To be able to work more efficiently in early phases and with Production Early Involvement there are three areas from the gap analysis: Information, Organisation and Focus. These need to be changed or improved in some way. To be able to work with or change the information flow and organisational structure, a change of focus is needed as a general mindset. A change in focus would be from the daily running production to a more long-term mindset where the strategy work has a larger impact on each function. This change could include work to educate the employees in why this change is important, what it includes and how this new focus will influence their daily work.

6.2.1 Information

Within the key area Information there are two subcategories: Communication & Collaboration and Requirements, see figure 18.

6.2.1.1 Requirements

The subcategory Requirements contains the most significant problem discovered in the interviews. In almost all interview answers about how IE communicates their requirements to ME was the opinion that there was no structure, either at VCT or VCG. On the other hand, in the interviews at ME and P&Q the respondents said that they have a process for communicating ME’s requirements to P&Q. This results in that the departments that work with ME as their only link to production, cannot understand that there is a problem regarding the communication of requirements from the plant.

There are several ways to solve this problem, one way could be to include IE in the process of communicating the Manufacturing requirements from ME to P&Q. Either by giving IE access to the program System Weaver where the requirements are communicated, or incorporating them more to be able to secure that the requirements come through to P&Q. Another way to solve the problem could be to use the method Lessons Learned. Both at VCT and VCG Lessons Learned has been used earlier and is in some occasions still being used, although there have not been many positive words about Lessons Learned in the interviews. Therefore, this work method would need a “reawakening” to make people believe in it again. This could be done by giving the method a new name and changing components that have not worked earlier, or integrating Lessons Learned into one of the new initiatives like Control Tower or the Logic meetings. This is important according to the theory about Lessons Learned in Chapter 3.5, because there is a risk of losing important information between or during the projects.

A method to communicate requirements, towards ME, that was mentioned during the interviews was the FMEA event. This process seemed to work according to the interviews but

needs to be prioritised by IE and Production. Using this opportunity and involving employees with the right competence could also be a way of communicating requirements.

To be able to succeed the communication of requirements to ME, IE needs to be clear and have a pointed motivation and reason for the requirement. It is also important, and mentioned in the interviews, that the requirement is written in a way so that ME can understand what the actual problem is. If ME cannot understand it, they will not prioritise it. This has, according to the interviews, been a problem at ME earlier. They have received Lessons Learned with requirements that were not motivated and could therefore not be understood. One way to motivate requirements could be to use the statistics that the VRT department has for customer complaints and quality problems that reached the customer. For those requirements that are for the earlier steps in the process, and do not affect the customer, IE should improve their own understanding of the problem before they write the requirement.

6.2.1.2 Communication & Collaboration

The first improvement that is needed to improve the communication is to open communication channels between the departments, for example, by common meetings. Some initiatives for this have already been taken, for example, at VCG through the Logic meetings. These are, according to the interviews with ME, going to be implemented at VCT as well. At both VCG and VCT the Control Tower meetings are used as a way to exchange information between the departments, which is a step in the right direction for improved communication. If this work continues, the capability of understanding each other's work between the departments will also improve. Then it will be more integrated events between them, which can result in less work in the "silos" mentioned in Chapter 4.3.1.1.

One reflection from the interviews was that if the amount of communication loops decreases, as well as the amount of people within the communication chain the risk for errors also decrease. For example, within a new car project, ME first makes the work instructions, which are later communicated to Plant Launch who completes the first balancing. When the mass production has started it is IE that is responsible for the balancing of the stations and should communicate changes in balancing to Production. At VCG the respondents described that they have more communication steps than at VCT, since Plant Launch is its own department and is not a part of IE as at VCT.

The amount of work could be decreased by increasing the frequency of daily communication. For example, if someone from ME has been working on a production solution, and afterwards IE gets involved and tries to change the production solution because they know it does not work in the running production. When this happens rework has to be done or compromise solutions are installed in the plant. If the departments would have talked to each other in an earlier phase, these rework or compromise solutions could be avoided. By working more together from the beginning, better solutions could be found by combining the skills of the people within the development process and running production, thereby a lot of time can be saved. Here non-value-added activities can be eliminated, since this is an example of "over processing" or "defects" from the 7+1 wastes, described in Chapter 3.4.2.1. The process is then not completed correctly from the beginning, and extra work must be applied for the finalised result. This is a clear example of the waste "unused employee creativity". The skills of the employees working within the running production are not used enough in the early phases within the creation process.

Another way to improve the structure of the daily work at the company could be to rearrange the placement of the employees. This rearrangement would result in different departments becoming closer to each other, which would minimise the number of meetings because questions can be asked directly. In Torslanda where ME and P&Q are placed as global organisations, IE at VCT should take advantage of this rearrangement more.

One observation done in this thesis work, was of a placement structure called "day@work", in the PV-building at the head office of the company in Torslanda. This structure was built so that there were no pre-decided seats or desks for anyone. Therefore, the employees were forced to integrate with different people every day, which opened new communication channels. This structure could be used in the plants too for the white collar workers to improve the communication between them.

6.2.2 Organisation

For IE to work more strategic and in early phases it seems like an organisational change is needed. Today the most common answer from the interviews was that the daily production takes up all the time, and even if there is a desire to work more towards early phases it is hard to get the time and actually do it. This answer was given from both VCT and VCG. This part about the organisation, is categorised within two parts, the first about the Organisational structure and the second one about Competence.

6.2.2.1 Organisational structure

A benefit that VCT has is that they are closer in distance to ME, since they are both located in Torslanda. From the interviews at both VCT and VCG, the daily connection and meeting points seemed to be important for the collaboration between the different departments. As described in the previous chapter, sitting in the same building makes it is easier to go and ask if you have any questions. An example of this is within the A-shop at VCT was IE, Production and ME Tooling & Equipment sits in the same building. This was mentioned in the interviews as a great benefit. This agrees with what has been said before in the interviews about "enginewers talking to engineers". When two departments are separated by a larger distance it can be hard not to have formal meeting points since the daily connections do not exist in the same way. It was expressed in the interviews at VCG that the employees do not always know who to contact at ME if there is a concern. It seems important to have both the formal meeting points and the increased daily connections in order to improve the work and to secure that all the departments are involved, even in earlier phases.

A common description from IE both at VCT and VCG was that the departments work within silos. One idea from some interviews, mostly at VCG, was that it is possible to keep the resources by making the responsibility area smaller and including tasks from ME, by combining both project work and running production. According to the interviews, some Process Engineers are working within projects and some within running. For example, when a new car is developed the ones working within projects work with the new balancing while in the running production another Process Engineer is responsible. To increase the quality of the work one idea was to decrease the area of responsibility, for example line length, so the same Process Engineer can be responsible both for projects and running production. By decreasing the area of responsibility, the Process Engineer will have the possibility to work both within early phases and in running production. A risk of doing this is that the same person needs to prioritise between the different areas, such as: daily running production, car projects, running changes, industrial projects and strategy work. Having that many areas of responsibilities

could result in that some areas gets higher prioritisation and others are forgotten. Another idea that came up during most interviews at VCT was that since the daily production easily takes over, the work should be divided, and some people should work within early phases and some within running. The difference between VCT and VCG might be explained by the differences in the organisations within the two plants. At VCG the responsibilities seem to be more divided, for example, in the C-shop there are three Senior Managers, one of which is responsible for forward models and earlier phases. At VCT it seems like it is more often the same person working with partly running production and partly early phases.

As seen above, there is no consensus description of how the ideal organisation would look; there are ideas about both joining work in running production and in early phases or dividing the work. Something that could be seen in most of the interviews was that better role descriptions are needed where the responsibilities are expressed in a clearer way. The importance of the work here is that it will look the same in the plants globally and between the shops locally. By working in the same way, it is easier to communicate requirements and understand each other, as well as communicate with the global departments, such as ME. Aligning the plants globally is also important to make sure the plants will not develop in different directions, as mentioned in the interview with VCES. A solution for this could be to have a new role within the organisations that works globally towards all IE organisations. This work could include aligning the work with the Vision Plant and making sure that the requirements from all the plants are the same.

Another organisational issue is that there is no responsible project manager from the plant and IE that receives the project. The reception of the project is handled by the functional line organisation and the people that have time for it. By having a clearer project organisation, it could be easier to secure that the right competence is available. The new role Project Manager at IE in VCT, could be seen as a step in the right direction.

6.2.2.2 Competence

Another concern brought up during the interviews was about the competence of working within early phases. It was about not having the right competence to be able to work within early phases and that if IE starts to work more in early phases, the experience and competence of the daily work could be lost.

Both at VCT and VCG it was brought up that there was doubt that everyone has the competence needed to work within the early phases. Being involved earlier, as mentioned before does not mean just attending different meetings and collecting information about the coming project. The early involvement is more about questioning the information and seeing what concerns can be brought to the plants. This means that it is important that people with the right skills are sent to these meetings, for example to the FMEA. This is in concurrence with the information about the waste “Unused employee creativity” in Chapter 3.4.2.1. When someone gets an invitation for a meeting it is important that it is confirmed that they have the correct skills to be involved.

A problem brought up, mostly at VCT, was the lack of employees with higher education within IE; many employees started to work within production and worked their way up. Even if their knowledge and experience of the plant is very large, they may lack some parts of critical thinking and knowledge about work methods existing outside of Volvo, that is taught at higher education institutions. This can possibly make it hard for some employees to work within early and to see the consequences a decision in early phases will have. To increase the

competence within the department, more internal education could be implemented or people with higher education could be included. There can also be a problem with employees who have a higher education, but not enough experience from the plant. Not having enough experience means it can be hard to understand how decisions will affect the plant.

To be able to use the competence of the employees it is also important to involve them in the work with the Vision Plant and the Guidelines. If they are going to be included in earlier phases, they need to agree upon what direction the plant should be developed. This also means that the global organisations would not receive different answers depending on who they are asking. The work with the Vision Plant and the Guidelines therefore needs to be communicated throughout the organisation and the employees would know it by heart.

The competence of working within early phases also depends a lot on the personality of the employee, and what motivates that person. It is therefore important to see that all the people working within the plant and IE have the right role. Some people might fit better into the running production and others within early phases. This is in concurrence with the Lean theory, described in Chapter 3.4.2.1, about using all the employees' competence.

To be able to use the competence that exists within IE and switch focus towards earlier phases either more resources are needed as mentioned in the chapter above, or some of the work within the daily production needs to be removed. An idea which came up though an interview was for Production to work more with VCMS in order to create more self-driven teams. By focusing on building up the organisation from the foundation and increasing the competence of the employees within Production, they can complete some of the work that IE does today, for example daily improvements. This would mean that some time would be released for the employees at IE, who can work then more within the earlier phases.

7. RECOMMENDATIONS

From the gap analysis, several potential solutions and recommendations for the company were found. By implementing these recommendations Volvo could be more efficient in their work with Production Early Involvement. Within the two areas Information and Organisation, the following are recommendations within each subcategory: Requirements, Communication & Collaboration, Organisational structure and Competence.

Requirements

- Involve IE in the process of setting manufacturing requirements from ME to P&Q.
- Make sure that IE has clear requirements and one united voice by, for example, working more with the Guidelines.
- Improve or make a new process for Lessons Learned, either by new work methods or a new name.

Communication & Collaboration

- Open new communication channels to involve the different departments and continue with integration event such as Control Tower and implementation of the Logic meetings in all the plants and shops.
- Increase the daily communication and reduce the number of long meetings. For example, rearrange the office space so the different departments are located closer to each other.
- Decrease the amount of communication loops by working more cross-functionally with Control Tower and Logic meetings, for example.

Organisational structure

- Clarify the roles within IE to divide the work between early phases and running production.
- Align the organisations globally, so the requirements are the same and the plants do not develop in different directions.
- Clarify roles and responsibilities so that everyone knows whom to contact, if there is a question or an issue.

Competence

- Make sure there is competence for working in early phases within each IE department. This can be done by either hiring new employees or developing the skills of existing employees, with for example internal education.
- Make sure everyone has the right skills by involving the employees in the work with the Vision Plant and the Guidelines.
- Keep the involvement in FMEAs. Secure that the attendants have the right skills to be able to communicate requirements in early phases.
- Make Production take a larger responsibility of the running production, based on the continuous work with VCMS, meaning that IE can move their focus towards earlier phases.

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8. DISCUSSION

The following discussion is divided into three parts, including discussions of the result and the method, as well as suggestions for potential future studies.

8.1 Discussion of the result

The recommendations given to the company need to be evaluated by the stakeholders' teams for example the IE and VCT Management Group together with the M&L Management Group. They must consider which of the recommended points should be used and prioritised to be able to be efficient within Production Early Involvement. This should be made in concurrence with the organisational changes within the other departments such as ME, even if those have not been dealt with in this thesis work. Some of the recommended points are connected to each other and can solve several problems, and other tasks may need several recommended points to be improved. For example, working with the Guidelines will both improve the competence of the employees as well as facilitating the setting of requirements for ME.

During this thesis work the writers have received the opinion that some points in the given recommendation are easier to implement than others, and that some of them are more important to improve the project work. The personal recommendation from the writers is to focus on improving the communication of requirements, regardless of which method or recommended point of improvement. The reason for this is that in most of the interviews this has been mentioned as a significant problem or area of improvement and there seems to be several ways to change it. Therefore, this point of improvement is chosen as the writers' personal recommendation.

8.2 Discussion of the method

In this thesis work a lot of information and knowledge has been collected during the work process. Therefore, the writers have discovered a paradox of knowledge. This paradox means that in the beginning of a project the knowledge about the result is the lowest, but the chances to influence it are the highest. Later the paradox means that in the end of the project the knowledge is the highest, but the chances to change the result could be almost non-existent. Some examples of this are in the process of selecting interview respondents where it was hard in the beginning to know which people in which roles should be interviewed. To avoid delays in the work process the advisor at Volvo had to give advices of which respondents should be selected, which could have affected the result. Additionally, it was also tough to know what format the study would result in because there was no strictly given directions.

Another relevant part for evaluating the method is to remember that the company is a global business located in several countries, and the writers have only visited VCT and VCG, complemented by a skype interview with VCES. Although parts of the global business have been described in this thesis work, this description should be seen as general to increase the overall understanding.

The study was performed during a total of five months, which meant that there was not enough time to perform interviews with all the people that could have been relevant. For example, more interviews could have been done with people from IE, Production and ME that work within the projects, to get a larger perspective. The time limitation was especially

noticeable during the visit at VCG, where the writers only had two days to interview the stakeholders. This resulted in the number of respondents becoming smaller than at VCT.

8.3 Potential future studies

This work has been limited to the plants at VCT, VCG and VCES. VCT and VCG are the oldest car production plants; the other plants that are newer might have different work methods that can be adapted. To make sure the best work methods are found globally, a similar study could be made in the other plants as well.

To continue the work at VCT, further studies can be made within the areas of recommendations. For example, studies can look more into how the manufacturing requirements are communicated from ME to P&Q, to find a similar model for IE. A new method for Lessons Learned could also be evaluated, to make sure the requirements from IE i communicated in a good way to ME.

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APPENDIX

Question template for IE

Current state

- Roles and organisation
    - What is your role or position within IE?
    - Can you describe your collaboration with the departments Manufacturing Engineering, Research & Development, Maintenance, Logistics and Production within projects?
    - What departments do you work with daily?
- Projects
    - In what phase of the project does your department at IE get involved? How does the involvement occur?
    - How does the hand over process for projects look today?
    - Who in your organisation gets involved first in car-projects and industrial projects?
    - Have you heard about "Production Early Involvement"?
        - Do your department work with Early involvement today? How?
    - Do you think it is a problem that IE is not involved earlier in projects? What is the problem?
- Information/Requirements
    - How are requirements communicated from your department to ME today?
    - How can it be secured that the requirements are fulfilled?

Future state

- Roles and organisation
    - How do you want to collaborate with ME, R&D, Maintenance, Logistics and Production in projects? Do you wish to work more with any department in the future?
    - Do you think your organisation is optimal to work with early involvement?
- Projects
    - How early do you think your department within IE should be involved in new projects?
    - How should the involvement occur?

- Information/Requirements
    - How can IE/the production plant be better on communicating their requirements to ME?
    - How can IE/the production plant ensure that the requirements are fulfilled?

Gap

- Do you have any specific idea how IE can work with early involvement in the future?
    - What is most important for your department?