Standardizing the Project Management process for New Product Development

Master's thesis in International Project Management

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CHALMERS UNIVERSITY OF TECHNOLOGY

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ABSTRACT

This thesis work was generated upon the lack of delivery efficiency and delivery deviations between projects conducted to develop new products by the hydraulic attachment tools division (HAT) of Epiroc, company acting in the mining and construction industry on a global scale. The aim of this work was therefore to analyze the current new product development process for the HAT product company in Kalmar (SE) and the one in Essen (DE) and identify and propose improvement to this process by standardizing the project management process for new product development on a divisional level. The objective therefore concerns the identification of main issues with the current new product development processes at Epiroc which generates most delays and inefficiencies in projects. In addition, the main obstacles to standardization of the process between both product companies were questioned, and finally the needed aspects enabling a standardization of the new product development process on a divisional level were established.

The hereby study represents a qualitative research using a abductive research approach and systematic combining. The qualitative data used to generate results was acquired through 21 semi-structured interviews with key members of both product companies and through 12 feedback sessions with similar key members. Triangulation of data was also used to support the authenticity of the study as well as a quantitative statistical analysis of key problem areas.

As a result, this study permitted the obtaining of a fully standardized first phase of a 5 phases stage gate process for new product development. The following 4 phases are developed but not fully standardized due to the discovery of deviations and disagreements in the organizational structure and stage gate approach. The cost allocation process, usage of the ERP system and difference in project manager roles between the two product companies represent the deviation hindering the possibility of a complete standard process for the HAT division. Disagreements such as location of phase transition, respect of theory and overlapping of phases versus frontloading were drawn from the deviations and thoroughly described as obstacles to the standardization of the divisional process.

Finally, this study proposes further research to be done and suggestion of key activities to complete in order to reach a fully standardized new product development process for the HAT division of Epiroc.

Key words: Project Management, New Product Development, Standardization, Stage Gate Process,

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Abbreviation list

Abbreviation	Description
AC	Atlas Copco
CTD	Construction Tools Division
DD	Design and Development
E	Essen
ERP	Enterprice Resource Planning
HAT	Hyrolic Attachment Tools
HAT/CE	Hyrolic Attachment Tools / Capital Equipment
ID	Identification
K	Kalmar
KPI	Key Performance Indicator
M	Manager
MD	Main Deliverable
MSP	Microsoft Projects
NPD	New Product Development
PC	Product Company
PDC	Product Development Council meeting
PK	Product Cost
PM	Project Manager
PP	PowerPoint
RD	Research and Design
VP	Vice President

Table of Contents

1. INTRODUCTION 10
1.1 Background/ Scope 10
1.2 Aim of the thesis 10
1.3 Research questions 11
1.4 Structure of the report 11
2 THEORY 12
2.1 Organizational Structure 12
2.2 Project Management 14
2.2.1 Product Development 14
2.2.2 Cross-Functional Work 24
3 METHODOLOGY 26
3.1 Research Method 26
3.1.1 Qualitative Research 26
3.2 Research Process 27
3.3 Research Strategy 57
3.3.1 Interview Methods 57
3.3.2 Data Analysis Theory for Qualitative Data 58
3.4 Evaluation of Quality 61
4 EMPIRICAL 64
4.1 Epiroc Product Company in Essen 64
4.1.1 Project Structure Essen 64
4.1.2 Communication Essen 68
4.1.3 Management tools Essen 70
4.1.4 Resource allocation process Essen 71
4.2 Epiroc Product Company in Kalmar 73
4.2.1 Project Structure Kalmar 73
4.2.2 Communication Kalmar 76
4.2.3 Management Tools Kalmar 77
4.2.4 Resource Allocation Process Kalmar 79
5 EMPIRICAL ANALYSIS 81
5.1 Statistical Analysis 81
5.2 Identification of Optimization Areas at Essen PC 90
5.3 Identification of Optimization Areas at PC Kalmar 91
6 ANALYSIS AND DISCUSSION 94

6.1 Current Stage Gate Process 94
6.2 Deviations and Disagreements 95
6.2.1 Deviations 95
6.2.2 Disagreements 96
6.3 Next Generation Stage Gate 97
6.4 Project Maturity 98
6.5 Project Outcome 99
6.6 Implementation 101
7 RESULT 103
8 CONCLUSIONS 111
8.1 Standardizing the Project Management Process for New Product Development 111
8.2 Recommendations for Epiroc 112
8.3 Further Research 112
9 REFERENCES 113
10 APPENDIX 116

1. INTRODUCTION

This chapter provides the background to the study. In addition, the aim of the study and research questions are presented. Finally, the structure of the thesis is explained.

1.1 Background/ Scope

In order to create complex value and success for projects in today's globalized world, the demand for projects to not only be managed but also formed internationally is expanding (Chalmers, 2017). The product life cycle is getting shorter, user demands increasing and competition is getting tougher generating a need for a rapid, lean, innovative and profitable new product development processes (Stošić & Milutinović, 2014). Most companies acknowledge innovation as a key driver of competitiveness and are investing considerable amounts of money on it but still fail to reap the benefits of inovativenss. Not because of issues in the invention or generation of innovative ideas, but as a consequence of the lack of successful management processes. One of the main issues with most processes appears to be the lack consideration of all important aspects to transform an idea into an attractive product on the market. Crawford (2014) claims that most organizations today, around 90%, only perform at a level 1 or level 2 out of 5 on the project maturity scale, mainly due to lack of knowledge and an established and standardized project management process. Countless projects and teams fail their innovation process due to performance issues caused by missing steps, activities and timelines, inadequate quality of execution and unreliable data, which can all be traced to poor organizational design and leadership (Cooper, 2007).

Epiroc is a global company in the mining and rock excavation technique business area, originating from the hydraulic attachment tools division of Atlas Copco. It was founded in Stockholm, Sweden and are today collaborating with customers in more than 150 countries. The Hydraulic attachments division (HAT) at Epiroc has struggled with delivering projects on time and has had a very big spread in delivery efficiency between projects due to the lack of a safeguard securing implying that all projects are executed and progressed in the same way. There has been extensive efforts for improving the new product development (NPD) process over the last years. The improvements were related to the deliverables on a high level which have had a significant impact on the delivery performance, but there is still more required to reach an acceptable level. Furthermore, there is an internal segregation within the division due to the location of the Product Companies (PCs) in two different countries: one in Kalmar, Sweden, and one in Essen, Germany. This complicates the possibility to compare projects between the two PCs and puts higher demand on a high performing NPD process with well-functioning communication in order to succeed in collaboration, sharing resources and knowledge transfer.

1.2 Aim of the thesis

The aim of the thesis is to identify actions and propose improvements for the NPD process at Epiroc by standardizing the project management process for new product development on a divisional level.

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1.3 Research questions

RQ1: What are the main issues with the current NPD process at Epiroc generating the most delays and inefficiencies in projects?

RQ2: What are the main obstacles to standardization of the NPD process between PC Kalmar and PC Essen?

RQ3: What is needed before a standardization of the NPD process at Epiroc HAT division is possible on a divisional level?

1.4 Structure of the report

The first chapter describes the background and clarifies the aim and research questions of the thesis. The following, second, chapter presents the literature framework to be used for analysis, including theory on organisational structure and project management. The third chapter contains the method used to obtain the result and thoroughly presents the process from the starting point of the internship during the summer of 2017 until the final thesis report delivered in May 2018. In addition, it contains an evaluation of the process, justifying the credibility of the study including ethical aspects. The fourth chapter describes the empirical material with regard to current situations for both PC Kalmar and PC Essen. Chapter five contains the empirical analysis that describes strength and weakness for both PCs, identifying key problem areas and thus answering *RQ 1*. It further justifies the standardization of the process on a divisional level as an improvement of the process. In chapter six the theory from chapter two is applied to determine existing obstacles and what is needed for a standardization of the process to be possible, hence answering *RQ2* and *RQ3*. The results in chapter seven present the proposed and partly agreed structure for a future standardized project management process for new product development for the HAT division at Epiroc. The eight chapter is dedicated to the conclusions of the study and declares suggestions for future research. This chapter thus fulfil the aim of the thesis and research questions.

2 THEORY

This chapter presents the theory used in this paper. First, organizational structure is elaborated. Second, project management is presented.

2.1 Organizational Structure

Organizations are defined by Kerzner (2013) as "group of people who must coordinate their activities in order to meet organizational objective" (Kerzner, 2013, p.93) which is further supported by the definition of organization given by the PMI (2013) stating that said organization are "systematic arrangements of entities (persons and/or departments) aimed at accomplishing a purpose, which may involve undertaking projects. An organization's culture and style affect how it conducts projects" (PMBOK, 2013, p.20). Furthermore, organizations are to be constructed by the members composing them therefore leaving place to several approaches to structure them. These approaches have to be tailored to the core values of organizations and to the desired outcome of organizations.

When establishing the organizational structure, three aspects are to be principally defined according to Kerzner (2013): authority, responsibility and accountability. Authority is defined as "the power granted to individuals (possibly by their position) so that they can make final decisions" (Kerzner, 2013, p.94) whereas responsibility represents "the obligation incurred by individuals in their roles in the formal organization to effectively" (Kerzner, 2013, p.94). With regards to accountability, the authors defines it as "being answerable for the satisfactory completion of a specific assignment. (Accountability = authority + responsibility)" (Kerzner, 2013, p.95). These aspects are to be initially establish regardless of which type of organizational structure an organization or company decide to implement. Still according to Krezner (2013), the most common organizational structure are traditional organization, projectized organization and matrix organization.

Traditional organizational structure

Kerzner (2013) defines traditional organizational structure as purely hierarchic in which all members have direct superiors leading to top management of company management. Moreover, traditional organizational structure consists of departments representing different functions needed to reach success in projects. Each of these departments are built hierarchically and work independently according to their respective functions and part of projects in accordance to the traditional organizational structure approach. Kerzner (2013) further describes traditional organizational structure as enabling easier cost planning and control as well as well-defined human resource allocation based on the skills required for each department. *Figure 1* displays an example of how a traditional organizational structure is built.

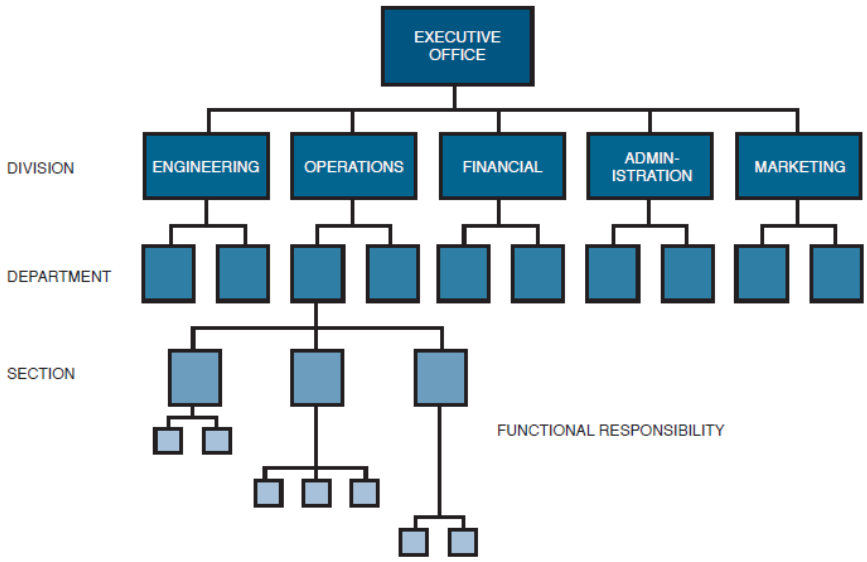

Figure 1 -Traditional organizational structure (From: Kerzner, 2013, p.96)

Projectized organizational structure

Projectized organizational structure represents the antipode of the traditional approach (Kerzner, 2013). Indeed, it represents the construction of organizations by projects in which department are actually project teams composed of a project manager and other needed functions reporting to said project manager. The projectized structure sees each project based team working on separate projects providing direct flow of information within each seperate team without having to necessarily go cross department for decision making processes (Kerzner, 2013). *Figure 2* displays an example of a projectized organizational structure as presented by Kerzner (2013).

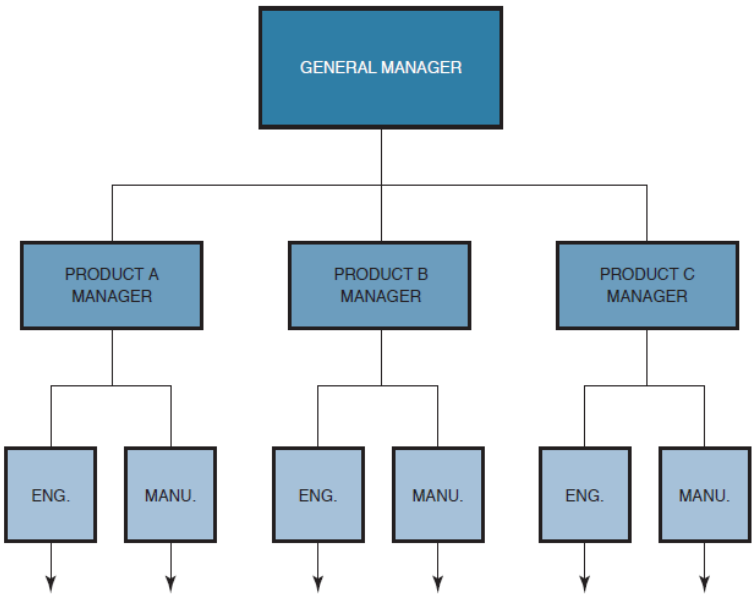

Figure 2- Projectized Organizational Structure (From: Kerzner, 2013, p.104)

Matrix organizational structure

The final widely used structure is represented by a matrix formed structure for which aspects of traditional structure and projectized structure are combined (Kerzner, 2013). Indeed, for a matrix organizational structure, project managers manage their projects through all departments for which functions are needed to bring projects to terms. In that sens, project managers have more control and responsibility over each functions involved in their projects and functional departments work on several projects at once reporting to different project managers (Kerzner, 2013). *Figure 3* displays a matrix organizational as presented by Kerzner, 2013.

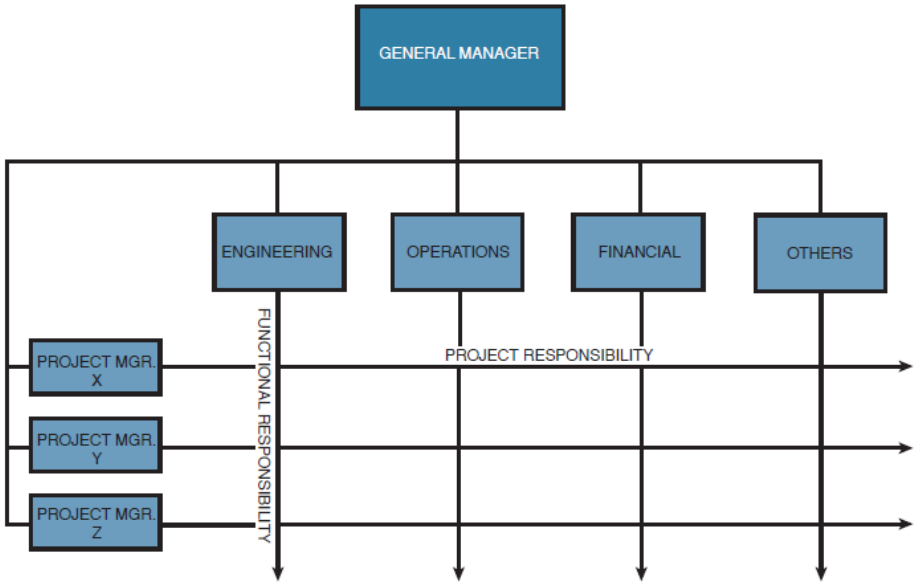

Figure 3- Matrix Organizational Structure (From: Kerzner, 2013, p.106)

As described above, all three organizational structures involve project managers and therefore project management. Indeed, organizations working with projects see project management as one of the key aspect to reach success and efficiency. The design or opted structure needs efficient project management in order to be valuable which therefore will be treated in the subsequent section.

2.2 Project Management

There are many definitions of Project Management. PMI (2013) describes it as a function that applies knowledge, tools, skills and techniques of project teams into activities in order to meet requirements given by the project and to reach goals. There is a growing need for projects to not only be managed internationally, but also to be formed internationally, to create complex value and success, due to the increasingly globalized organisational culture (Chalmers, 2017).

2.2.1 Product Development

In the current business world, the life cycle of a product is decreasing, competition is getting tougher and the demands from users are increasing (Stošić & Milutinović, 2014). The requirement of a rapid, lean and profitable new product development process is thus more essential than ever.

Stage Gate process

Due to today's knowledge-driven economy, innovation seems to be the central element, one of the identified key drivers for enhancement of competitiveness and has hence become a key priority for the organizations striving to become the leading company in the field (Stošić & Milutinović, 2014). Even though most companies acknowledge the importance of innovation and spend a considerable amount of money on it, the generation of reasonable profit and/or competitive advantage has been questioned. However, the primary issue is not the invention or generation of innovative ideas but rather the lack of a successful management process, considering all important aspects to transform the idea into an attractive product in the market. According to Rothwell (1992), there are six generations of innovation models, starting at simple linear processes to very complex interactive network ones, see *Table 1* below.

Table 1Development of innovation model (Rothwell, 1992, p.6)

Model	Generation	Characteristics
Technology push	First	Simple linear sequential process, emphasis on R&D; market is the recipient of the R&D results
Market pull	Second	Simple linear sequential process, emphasis on marketing, the market is the source of new ideas for R&D; R&D has a reactive role
Coupling model	Third	Recognizing interaction between different elements and feedback loops between them, emphasis on integrating R&D and marketing - Stage-Gate process, - The Collaborative Innovation Process
Interactive model	Fourth	Combinations of push and pull models, integration within firm, emphasis on external linkages - Minnesota Innovation Research - Program (MIRP) model
Network model	Fifth	Emphasis on knowledge accumulation and external linkages, systems integration and extensive networking - The Creative Factory Systems Innovation Model
Open Innovation	Sixth	Internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies

The linear models, first and second generation, are either pushed by technology/science or pulled by the market needs (Stošić & Milutinović, 2014). The third generation model is classified as coupling due to the recognition of both influences from technological capabilities as well as the market needs. The main representative for the third generation is the Stage Gate model defined by Cooper as "a conceptual and operational map for moving new-product projects from idea to launch" (2007, BOOK24: chap 4). The model divides the product innovation process into a sequence of stages, together with a set of parallel activities and gates. The success factor of the model, which makes it very popular and widely applied, is the possibility to integrate a number of practices into one process which is easy to understand.

The Stage Gate process consist of a series of cross functional stages, all completed with a gate where pre-decided deliverables and criteria are evaluated (Grönlund et al., 2010). Each stage consists of a set of essential activities which can be performed in parallel in order to enhance speed to market. Which activities to perform depend on what stage the project currently is in. The gates operate as stop/go where decisions for the future of the project are made. The evaluation of the project and decisions at the gates are made by a cross functional steering committee, suitably consisting of a group of senior managers, called Gate keepers. The gates contain three fundamental elements: deliverables, criteria and output. The deliverables are the project team and managers

contribution, serving as the input to be reviewed by the Gate keepers. There should be a standard set of pre-defined deliverables specified for each gate, based on the result of the activities executed in the preceding stage. The project is further evaluated by the set of criteria, usually organized into a scorecard including both quantitative and qualitative criteria. Examples of criteria include strategic fit or expected profit. Finally, the actual result of the Gate review; the output, which consist of a decision to stop/go and an execution plan with dates and deliverables for the next gate review.

Activities can depend on both previous and upcoming stages, thus should not be seen as independent information, but a correlation or information flow (Jespersen, 2012). The selection of NPD activity in one stage may influence the selection of various activities in the following stage, as well as the subsequent one, creating a branch or a path of information. This branch can be influenced by several activities, where the activity dependency may exceed several stages.

The gates has been rated the weakest point in this process for most companies due to the lack of tough, rigorous gates throughout the idea-to-launch process (Cooper, 2007). With a robust gating system, projects in trouble are detected and steered in the right direction and poor projects are found and killed early in the process. Companies commonly have too many minor projects developed at parallel, where too many bad projects and too many projects in trouble are sliding through. This phenomenon is called "Gates with no teeth", once a project has been approved it never gets killed. A common cause is that management does not know how to say "No". The meetings are held with the best of intention to critically evaluate, but instead of being a serious Go/Kill decision meeting they tend to be nothing more than a project update, a review meeting or a milestone checkpoint: -is the project on time and on budget. The issue of "should we keep investing in this project" is often skipped/forgotten. The key is that the process is a funnel, not a tunnel, where all gates are Go/Kill decision points, not just the first one which would create a "five stage, one gate"-process. Because this is an option model, early decision to move forward can be reversed at later gates. Projects often look good in the first stages, but as the process moves forward new information arise or markets change, which will also change the feasibility of the project. Therefor the decision to kill a project has to be considered at all gates and, if necessary, made. Another problem are hollow gates. The meetings are held and projects are approved, but resources are not committed. To successfully move forward, the project team leader must leave the meeting with the committed resources needed to progress their project.

The Stage Gate model has been described as playbook which maps out both what needs to be done and how to do it in order to "win the game" (Cooper, 2007). Countless projects and teams fail, often due to lack of performance generated by missing steps and activities, missed timelines, unreliable data, inadequate quality of execution and poor organizational design and leadership. The Stage Gate model is hence considered to be a guide for the steps of the winning teams, taking the project from an idea to launch. Furthermore, it is highlighted that the New Product Process is more than just a flow chart. It should include all process elements; Stages, Gates, Stage activities, Deliverables and Gate criteria.

However, there have been criticism towards the model where it is said to be time consuming due to timewasting activities, bureaucratic procedures, no provision for focus and restriction of learning opportunities (Grönlund et al., 2010). As a reaction to

the criticism, the "Next-generation Stage Gate process" was created. The new process incorporate a series of overlapping, fluid stages with conditional-go decisions. Many companies today are modifying, adjusting and adapting their Stage Gate process in order to make it better, faster and more productive. Examples of improvements are scalable processes to suit different types of projects with different sizes and risks levels, making the process more agile by applying concurrent activities, overlapping stages and conditional GO-decisions, lean production, open innovation and automated Stage Gate approved software (Cooper, 2007). This third generation innovation model further incorporates six F:s (Cooper, 1994):

- Flexibility
- Fuzzy
- Fluidity

  } Enables overlapping of stages which can be approved conditionally, allowing the process to be scaled to various size projects.
- Focus → The process is connected to a strategy.
- Facilitation → Specific gate keeper to ensure proper guidance of the process.
- Forever green → Continuous improvement of the process.

Stakeholder management

Due to the growing globalisation and stronger competition, the use of Stakeholder Management tools is increasing and becoming more widespread (Huber et al, 2006). The concept has developed from exclusively focusing on the corporate activity for interest groups, such as customers, employees, shareholders or suppliers, to becoming an integral part of the daily business within the organisations. In order to fulfil the stakeholders needs, requirements, address issues and engaging them into project activities, there has to be a well-functioning process of communicating and working with the stakeholders. PMI (2013) refer to this process as Manage Stakeholder Engaging which allows the project manager to minimize resistance and increase support.

TRI*M is one of the leading branded solutions in Stakeholder Management and has been proved to be a successful tool (Huber et al, 2006). It stands for Measuring, Managing and Monitoring and is gaining momentum in several areas and at all levels of companies and institutions. The quality of relationships between companies/institutions is Measured, then Managed by developing actions aimed at improving these relationships, and finally continuously monitoring the effects of it. In order to successfully Monitor and Manage stakeholders, a communication management plan can be used (PMI, 2013). Identification of all stakeholder is done by doing a stakeholder analysis. One example is the Power-Interest stakeholder map, as shown in *Figure 4* below. The right amount and type of communication is then determined and applied based on the stakeholders' interest in and power of the outcome of the project. It is then decided how, when and what communication method to use based on the identified stakeholders' requirement. The flow of data in this process is shown in *Figure 5* which identifies and documents the most effective and efficient ways to communicate.

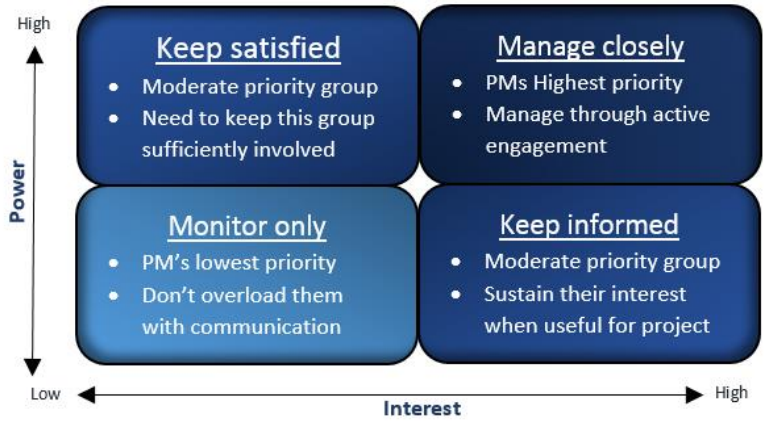

Figure 4. Power-Interest stakeholder map (Adapted from: Maylor, 2010, p.83)

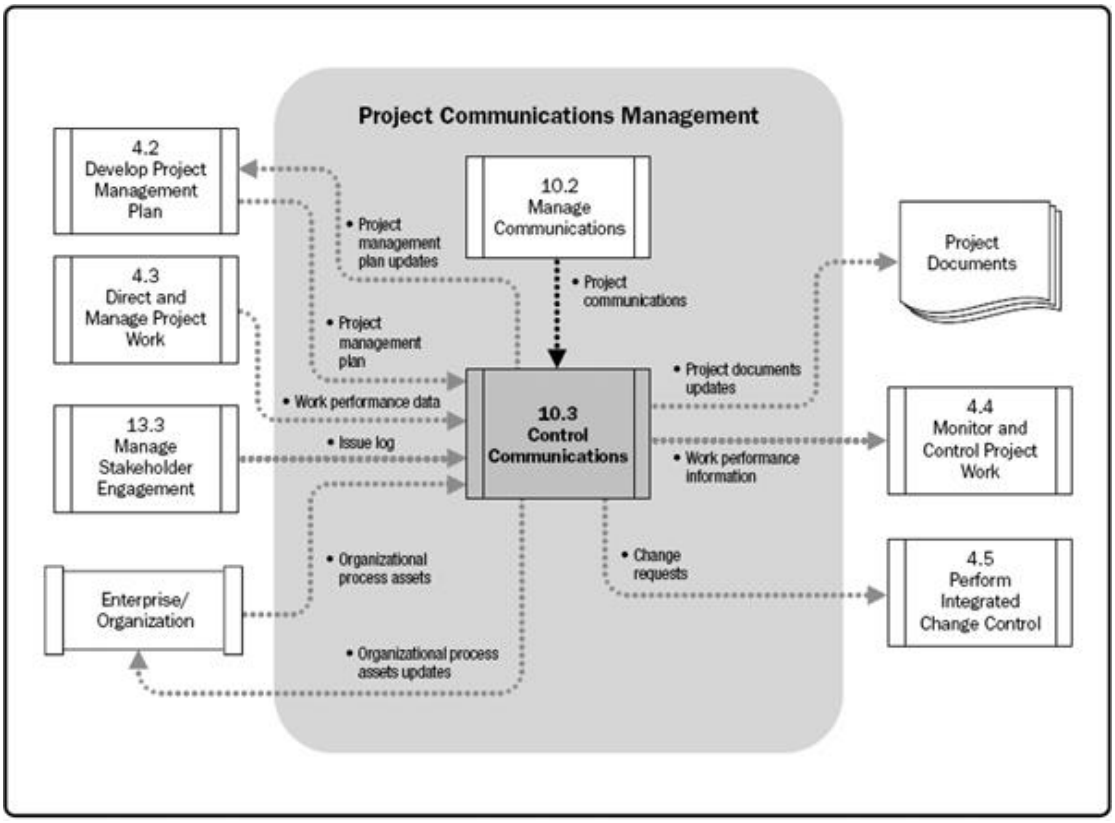

Figure 5. Project communication management: data flow diagram (PMI, 2013, p. 304)

It is indeed a challenging task to please and connect all stakeholders, especially with diverse organizational backgrounds, cultures, levels of expertise, perspectives and influence of the projects execution and/or outcome (PMI, 2013). Thus, the importance of effective communication which may function as a bridge, monitored by the communication management plan. It is crucial that the plan follows every step of the project life cycle and includes the processes needed to establish appropriate planning, creation, collection, storage, distribution, retrieval, controlling, management, monitoring, and final disposition of project information. *Figure 6* illustrates the three processes which project communications management can be divided into, where each process includes communication activities with various dimensions which needs to be considered.

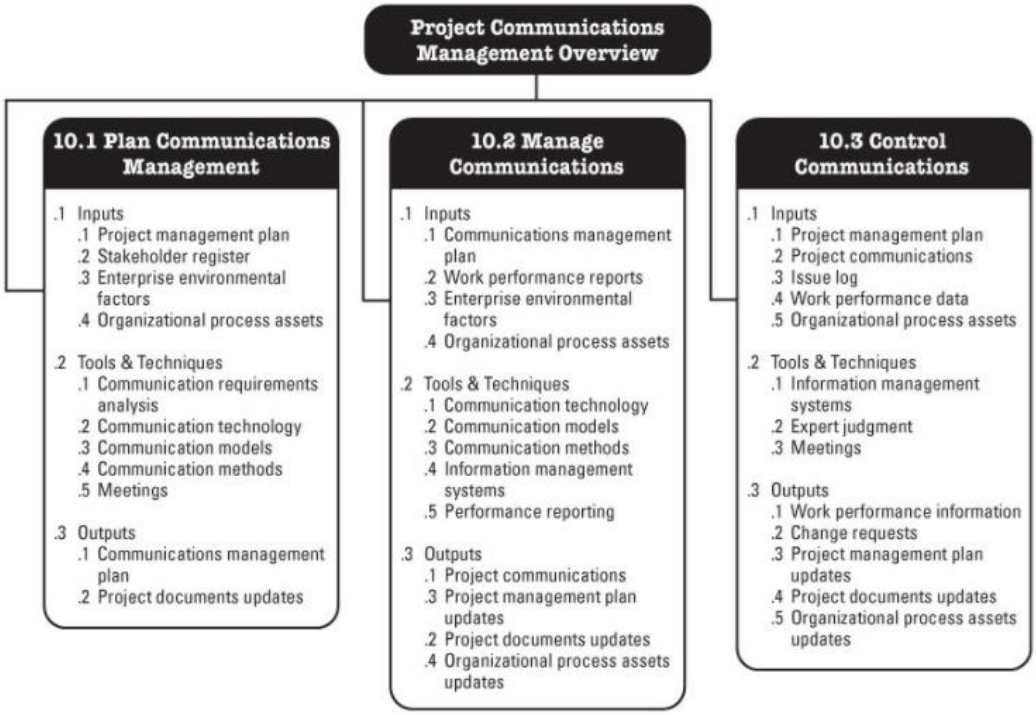

Figure 6. Project communication management overview (PMI, 2013, p. 288)

Project time, cost, safety and quality are all affected by poor communication during a project, thus the importance of defining and determining the methods to be used and setting the communication plan as early as possible. The communication plan should include the following; (Zulch, 2014, p. 1002):

- **Who**: lines of communication -> sender and receiver -> responsibility and authority
- **What**: scope of communication and format
- **When**: schedule
- **Feedback**: confirms message received and understood; document control
- **Filing**: retrieval, storing, disaster recovery
- **How**: email, document, telephone, meeting, presentation

Project management techniques

Kerzner (2013, p.4) defines project management as "the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives" together with the application of knowledge, skills, methods, tools and techniques to achieve these objectives. The main focus for projects is considered to be delivering change which is a difficult task to manage (Tayntor, 2010). The fact that each project is temporary with a defined end, are unique and with temporary staff often "borrowed" from various departments brought together for this one endeavor, does not make it any easier.

The Project Triple Constrain-model is as a tool for the project manager to keep all aspects of the project in line (Tayntor, 2010). All projects are most likely constrained by three elements; time, resources and scope, forming the triple constrain triangle (see *Figure 7*). In the triple constrain triangle time is the project time plan or schedule,

Resources are budget and people, and Scope is the demanded functionality. All three constrains affect each other and need to be in balance, for instance, if the time frame needs to be extended due to a delay, at least one of the other constrains need to compensate by either reducing the scope or adding more resources. A projects success or failure is judged based upon these three constrains (Kerzner, 2013). Balancing them is thus considered to be the essence of project management (Tayntor, 2010; Wysocki, 2013). All three constrains need to be fulfilled to an acceptable level and then prioritized with regard to the success factors important for the specific project (Wysocki, 2013).

Figure 7. Triple constrains (Adapted from Papke-Shields et. al, 2010, p.653)

The way organizations use project management and the available techniques differs and depends on various factors (Tayntor, 2010). Measuring to what extent an organization is applying project management techniques can be referred to as "Maturity" where one of the most popular tools is the Capability Maturity Model (CMM) created by the Software engineering institute at Carnegie Mellon University (SEI). It is an excellent tool to start examining the project management capabilities. CMM is considered to be design methodology to improve the development and delivery rather than just a measurement, aiming to prevent runaway projects and contributing to produce every system on time and budget. The method is using a maturity path including five maturity levels called milestones (see *Table 2*). Although the CMM was originally design specifically for software projects, it can be applied to any type of project to help the project manager assessing the projects progress of the organization along the path of maturity.

Table 2. SEI CMM levels (Tayntor, 2010, p.6)

Level	*Description*	*Characteristics*
1	Initial	Results are unpredictable, because they are dependent on individuals' skills and efforts.
2	Repeatable	Basic processes have been established on a project level, making it possible to replicate performance on similar projects.
3	Defined	Standard processes have been integrated across the organization and are used consistently on all projects.
4	Managed	Detailed measurements and quantitative controls make it possible to predict results.
5	Optimizing	The organization actively seeks to improve the process through innovation.

There are two different approaches to determine the organizations level of maturity (Crawford, 2014). The first approach is called independent assessment where project management experts conduct the assessment by using a prescribed set of tools and processes to determine the organizations maturity level in various knowledge areas. The result is presented to the organizations management team which are then to work together with the assessors to develop an implementation plan. This is the method to prefer if an "external expert voice" is needed. The second approach is called facilitated self-assessment where a small team of experienced assessors work together with representatives and staff from the organization to determine the maturity level following the same process as for the independent assessment. The main challenges with this approach is to maintain the confidentiality of individual findings and the possibility of false results due to inherent bias toward higher level of maturity. Organizations will improve significantly by reaching higher levels of maturity and realize valuable results such as shorter project completion times, improved project cost control, strategic management decision and long term sustainable growth and profitability.

Furthermore, Crawford (2014) claims that most organizations, around 90%, are performing at level 1 or level 2 maturity. To reach level 3 all project management processes need to be in place and established as standards. Management is regularly involved in input and approval of key decisions and project issues and projects are not only evaluated but also compared and evaluated to other projects. Level 3 further demands a process that can be tailored to all projects and consider the different characteristics between projects (complexity, size, duration) and does not blindly apply all processes equally to all projects.

Attaining level 4 requires the organization to take all processes implemented and standardized at lever 3 and further integrate them with other corporate processes and systems, managing and measuring the performances with efficiency and effectiveness metrics to make decisions about projects (Crawford, 2014). It is further understood that these decisions may have an impact on other projects and the correlation between all projects in the organization. The management role in the project management process is clearly understood and executed well, adapting style and requirements depending on the characteristics of the project. Finally, the business decisions are optimized by the

integration of the project information to other corporate systems such as finance and accounting, strategy management, and resource management systems.

The organizations that perform at level 5 are the first-rate organizations which sets the standard for the project management disciplines within their industry and have formal processes in place to continuously improve their project management activities (Crawford, 2014). Lessons learned are examined frequently to increase the profitability and success for future projects by using the information to improve management standards, documents and processes. Finally, the metrics are used to support effective management decisions on how to go forward on an organizational level, not only to understand the performance of a project.

PMI (2013) describes project management as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements". One of the biggest challenges of project management is to respect the agreed constrains and at the same time achieve the specific goals and objectives (Maley, 2012). The goals are broader and more general in oppose to the more concrete and short-term objectives as described in below *Table 3*. Further advice is to create SMARTER goals and objectives; Specific, Measurable, Achievable, Relevant, Time-bound, Engaging and Rewarding. However, the primary triple constrains are not always enough, thus, the suggestion is to extend the constrain and to include the risks, business benefits and quality of project delivery (Maley, 2012). To successfully bring this about, the discipline of planning, organizing and managing resources needs to be in place.

Table 3Difference between goals and objectives (McLeod, 2012, p.68)

Goals	Objectives
Broad in scope	Narrower in scope
General	Specific
Intangible	Tangible
Qualitative	Quantitative
Abstract	Concrete
End result	Required steps
Hard to validate	Easy to validate
Longer-term	Shorter-term

The purpose of project planning is to determine the projects specific parameters to ensure that all preparations for the project execution and control are in place, giving the opportunity to plan and prepare instead of reacting to catch up (Maley, 2012). The main goal is to create a project plan and schedule to present to management for subsequent approval. The planning phase builds on the foundation of the scope and translate the initial objectives into concrete deliverables and a detailed schedule (Tayntor, 2010). The project definition and scope are then validated by identifying relevant stakeholders. The "Five W" can be used as a guideline when planning a project. Identifying the scope should answer the first question: *Why*, followed by the planning which purpose is to provide detailed answers to the remaining four: *Who*, *What*, *When*, and *Where*. The project scope, schedule and budget are first developed, clarified and approved, followed by the application of deliverables to the initial project plan which are then developed,

enhanced and re-defined until they constitute a definitive plan for the project (Maley, 2012).

Project planning is an iterative process and should be performed in parallel with the product problem analysis and solution design, synchronizing both the project planning but also the product planning (Maley, 2012). Early knowledge of product requirements and design is desirable as it greatly support the structuring of the project. The work that has to be performed is identified as the work breakdown structure, and describes more thoroughly as more information is contained during the project. Each identified task is then quantified to establish its duration and cost, also called the estimation. Effective estimation demands a deep understanding of variance in estimating and how to account for/ govern it. It further requires the project manager to accept that the estimation is based upon assumption and incomplete information and then be passed it on to all team members. Behavioral issues also needs to be considered in estimations since perspectives tend to vary depending on the managerial level: senior people tend to underestimate while junior people tend to overestimate, lower organizational levels tend to swiftly add reserves while upper levels delete them. Once the estimations are done the logical flow is decided by establishing the sequence of the identified tasks.

A project manager needs to quickly and accurately process a great amount of data to confirm the complexity of the schedule, thus effectively plan and control the project (Maley, 2012). Two scheduling steps which are key for successful time management planning, cost management planning and resource planning are the activity network and the activity scheduled bar chart, also called a Gantt chart. It is a highly structured and methodical approach which illustrates the project schedule against a calendar. The activities are represented by a bar, stretching horizontally from its start to end date and answer the question "When the activity will be performed". It is the output of the planning and schedule and the most common graphic-representation in projects and can only be created after the scope of work, work breakdown structure, activity estimation and logical flow, also described as inputs, has been determined. It is appropriate to use a project management software to create the Gantt chart as the significant amount of available project planning data will be too much to manage manually. However, the Gantt chart only represent one of the projects constrains, the schedule, but does not consider the size of the project, required resources, funding or risks. Combining the information in the Gantt chart together with the estimated budget and product plan is one way to handle the recourse constrain (Wysocki, 2013). The budget is also an important criteria when deciding if a project is a go/ no go. Having clear goals and objective further control the scope constrain.

As all projects are unique and temporary operations based on assumptions and constrain uncertainty is inevitable (PMI, 2009). Furthermore, projects deliver results to multiple stakeholders with diverse requirements. In order to control these uncertainties present in most organizations, structured and disciplined techniques such as estimating, task allocation, planning, cost control etc. need to be in place.

Project Risk Management is a critical success factor and needs to be an integral part of project management (PMI, 2009). The definition of risk includes two key dimensions: uncertainty (probability) and effect on a projects objectives (impact), which are equally important to consider when assessing the importance of a project risk. Risks can be considered on two levels. The first level, individual risks are specific events or

conditions that affect the project objectives. Good understanding of these risks helps to decide when and how to apply activities and resources to secure a successful outcome of the project. It is recommended for project risk management to focus on these risks on a daily basis. The second level is the overall project risks which represent the impact of uncertainty in the project and is more than just the sum of the individual risks. These risks apply for the whole project as a whole, not just its individual elements or tasks, and represent the exposure of stakeholders to the indication of variations for the project outcome. The overall project risks are key elements for the strategic decision making, portfolio management and project government since it affects where investments are made and priorities are set.

The cause-risk-effect chain is a useful tool for structured risk statements or risk description (PMI, 2009). Causes are currently existing circumstances or events which are certain to exist in the future and may give rise to risks. Effects are referred to as conditional future events or conditions which if a project risk occurs would specifically and directly impact the project objectives. Management of project risks are everyone's responsibility and should not be left to a few "risk specialists". It needs to be an integral part of all other project processes where all risks are documented and allocated to a responsible person for specific activities within the risk process to ensure that risk-related lessons are secured for future use. The output of the project risk management process should be accounted for in most project management processes (PMI, 2009):

- Estimating resource requirements, cost, or duration.
- Assessing the impact of proposed scope changes.
- Planning or re-planning the forward strategy of the project.
- Allocating resources to tasks
- Reporting progress to stakeholders.

To identify the risks, scope and objectives are agreed upon by the project team and stakeholders. Genuine risks are then identified, and carefully distinguished from causes and effects. The aim is to expose and document all knowable risks, keeping in mind that some risks will be inevitably unknowable while others will emerge as the project moves forward. There is a variety of risk identification techniques to use, all with their own specific strengths and weaknesses. The emergent nature of risks creates the requirement for the project risk management to be an iterative process, continuously analysing and evaluating the risks.

2.2.2 Cross-Functional Work

Organizations are commonly composed of members with different tasks, knowledge and functions whom need to come together to deliver the required service or product in order to meet the organization's goals successfully. The combination of functions is referred to as cross-functional teams, or work, and relates to "groups of people who apply different skills, with a high degree of interdependence, aimed at reaching a common organizational goal" (Holland et al., 2000 in Marasquini Stipp et al., 2018, p.86). Edmondson and Nembhard (2009) describe cross-functional work as the combination of crucial capabilities enabling problem solving and growth of project for an organization. Furthermore, cross-functional work is described as having high importance in organizations by Leenders and Wierenga (2002) as the effective interaction of all relevant functions increases efficiency and development of thorough

solutions. Analogically, Anthony et al. (2013) argue that the well being of cross-functional work has direct impact on communication and therefore respect of time in organizational projects. Other results of cross-functional are described as "increased individual involvement, better problem-solving, creative solutions and effective implementation of decisions" (Donnellon, 1993; Webber, 2002; Jugend et al., 2015 in Marasquini Stipp et al., 2018, p.86) and have a direct impact on project performance.

In addition, Blank (2013) outlines that cross-functional work and development as complementary to the traditional performance enhance methods to indirectly increasing the organizational efficiency. Blank (2013) further describes four key aspects of cross-functional work relating to processes in product companies such as the one studied in this thesis. These aspects are described in the *Table 4* below.

Table 4- Aspects of Cross-Functional work (Adapted from Blank, 2013, BOOKS24 Chap.7)

Cross-Functional
Involves many different departments such as human resources, purchasing, and maintenance as well as manufacturing and quality
Emphasis on tooling and equipment as well as people and technique
More emphasis on preproduction activities like contract review, purchasing, design verification and validation, and inspection planning
Greater role of preventive maintenance as scheduled by actual data

Moreover, the implementation of cross-functional work can be seen as complicated in a highly traditionally built organization. According to the PMBOK (2013), facilitated workshops represent an ideal manner to improve cross-functional work. Indeed, holding workshop is a mean to involve all stakeholders of a project or process and establishing the goals of said project or process and the functions required to achieve success (PMBOK, 2013). A recommended project management tool to improve cross-functional work is described by the PMBOK (2013) as group creativity techniques. The most popular techniques are represented by brainstorming, which can be seen as the generation of ideas or solutions between all involved functions/stakeholders to reach project success, and mind mapping, which can be described as the comparison and analysis of the status of interaction between the functions involved in the ideas drawn from the brainstorm (PMBOK, 2013)

3 METHODOLOGY

The following chapter regards the methodology used to fulfil the aim of this thesis work. The chapter describes the research method used as well as the research process followed throughout this project.

3.1 Research Method

The research strategy presents theory and explanation of the research approach. An abductive approach and systematic combining has been used in terms of qualitative research strategy to achieve considerable outcome in this project and will therefore be presented as a support to the research process.

3.1.1 Qualitative Research

For the aim of the study, qualitative research, and therefore qualitative data, represents the chosen approach to generate results. According to Auerbach et al (2003) "Qualitative research is research that involves analyzing and interpreting texts and interviews in order to discover meaningful patterns descriptive of a particular phenomenon" (Auerbach et al, 2003, p.13). By that meaning, the authors argue that qualitative research and the analysis of qualitative data represent non numerical information acquired through testimonies from informants or individual with tangible experience regarding the matter researched. Furthermore, Auerbach et al (2003) describe qualitative research as a method through which hypothesizes are generated from the data drawn from interviews as opposed to initiating the research with the goal to confirm or infirm a pre conceived hypothesis (quantitative research). Moreover, DeFranzo (2011) argues that qualitative research and its generated hypothesizes can be used as foundation for further quantitative research.

Abductive approach to qualitative research

According to Blaikie (2010) in Kok Ong (2012), the abduction approach in qualitative research represents the "process of generating social scientific accounts from social actor's account" (Kok Ong, 2012, p.422). The author further argues that abductive approach stands to analyze the everyday behavior of, in this case, members of an organization in order to formulate hypothesis adapting to said member's comportment and ways to function. Furthermore, the abductive strategy for qualitative research is displayed by Blaikie (2000) in Kok Ong (2012) as having for aim "to describe and understand social life in terms of social actors' motives and accounts" (Blaikie, 2000 in Kok Ong, 2012, p.424) describing that experiences and actual insights from knowledgeable actors permits the generation of hypothesis.

Abductive research approach is also used stand adopting a systematic combining approach to a qualitative research as described by Dubois & Gadde (2002). Systematic combining is a constant iterative comparison of empirical study and theory during the entirety of the qualitative research period. Dubois & Gadde (2002, p.555) describe this concept as a researchers "going back and forth from one type of research activity to another and between empirical observations and theory" allowing researchers to generate more depth in their analysis of the matter researched. Dubois & Gadde (2002) further argues that this method also permits redirection of the qualitative study as it progresses to achieve desired and more accurate hypothesizes by the combination of the empirical data acquired, the theory researched, the actual study or case and its framework as shown in *Figure 8* below.

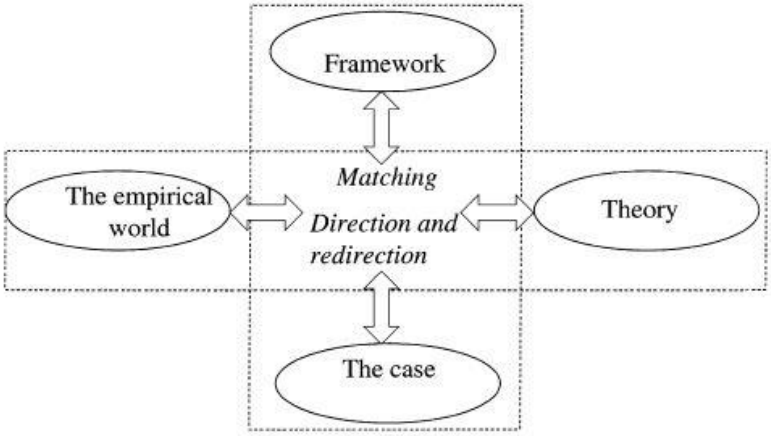

Figure 8 - Systematic combining model (From: Dubois & Gadde, 2002, p.555)

Figure 8 presents the importance of iterative matching of theory and empirical knowledge leading to the possibility of maintaining the direction or redirecting the study and its framework.

Triangulation of data

Triangulation of data in qualitative research represents a strategy of validation and support of generated hypothesizes. According to Flick et al. (2004), qualitative data can be triangulated given its compared from at least two different acquisition origin to validate its authenticity. Furthermore, triangulation of data can also be done between qualitative hypothesis and quantitative data drawn from the qualitative research.

The research process presented in the next section therefore uses abductive approach to qualitative research and systematic combing to reorient the aim of the project in accordance to the findings.

3.2 Research Process

The following section illustrates a step by step description of the actions taken during the thesis work in order to investigate the phenomenon. This section regards all major decisions made from the origins of the scope to the production of the final written report and has as objective to generate a thorough understanding of our research process from the reader.

The Internship

The initial point from which this master thesis was generated comes from the *International summer internship program 2017* completed by thesis co-writer Sébastien Smith prior to the final year of the master's program in International Project Management. Upon contract, Smith had the option to complete a master's thesis at the company bringing in co-writer Carolina Hansson at the start of February 2018. The internship was conducted with the Construction Tools Division (CTD) of at the time Atlas Copco AB (now HAT division of Epiroc) and had for objective to assess possibilities to reduce total project cost and increase speed to market for new developed products for the division.

For the internship, lower cost resources in company offices in India and Bulgaria were assessed on their capacities following design, project management, communication and resource allocation to establish to what extent de-located resources could be used in new product development project in order to support the engineers in Sweden. Furthermore, the CTD (now HAT) office in Essen (DE) was also used as a reference during this internship as it was already working with lower cost de-located resources in Bulgaria and India. The outcome of the internship resulted in a proposal for a pilot project that had for objective to increasingly outsource more engineering work to de-located resources and liberate more time for engineers in Sweden and Germany to spend on more important projects and issues. This internship ended in August of 2017 with the Idea to continue with optimization of new product development process for the thesis in the spring of 2018.

Involvement of Essen as stakeholders in the Master Thesis (Week 46, 2017)
Following the above described internship, discussion during the autumn 2017 permitted the HAT product company in Essen Germany to manifest their interest in becoming stakeholders in the thesis which led to the thesis being on a divisional level instead of an office level. Indeed, after being used as a reference for the internship project, the product company in Essen requested to be equally involved in the master thesis project and share the equity equally with the product company in Kalmar. Upon these communications, the stakeholders for the thesis were established as being half in the Epiroc office in Kalmar and the other half in the Epiroc office in Essen.

The scope of the thesis was also discussed during the autumn communications in the form of a brain storming session with stakeholders from both Kalmar and Essen. As mentioned above, the outcome resulted in aligning the aim of the scope similarly to the general objective of the internship as its continuity. Ideas from this brain storming session therefore stayed oriented towards limiting costs and delays on projects by developing strategies to optimize the new product development process.

First scope proposal and first stakeholder meeting (week 5)
The beginning of February marked the first scope proposal that we brought to the first meeting involving all stakeholders from PC Kalmar and PC Essen. The meeting took place over teleconference and shared screen and involved the VP of R&D, the R&D department manager from Kalmar and from Essen as well as two design engineers and project managers from Essen representing our thesis supervisors for the Epiroc unit in Essen. During this meeting presentation of all involved members of the organization and us students were made as well as the first proposal of scope for the thesis which was approved by all stakeholders. This scope was kept general in order to allow possible reorientation of aim and concerned the improvements to be brought to the new product development process. Upon approval, this scope proposal was officialized and used for registration of the master's thesis at Chalmers Tekniska Högskola.

This first meeting also was used to cover all ambiguities regarding the deviations between the Swedish education system and the German education system. Indeed, as the format, length and outcome of a master's thesis in a Swedish engineering university are very different from one in a German engineering university we had to clarify the expectations and requirements given by Chalmers for this project. Further clarification with regards to our contracts were held during the conference and the decision to first visit the product company in Kalmar during week 7 was made.

Official start of the thesis

The official start of the thesis project took place beginning of week 6 at Chalmers Tekniska Högskola where we held meetings every day in order to establish the complete project time plan, develop our approach to fulfil the aim and answer the research questions and discuss our personal goals and expectations for this Master's thesis. With regards to the personal goal with this thesis, we both agreed to aim at fulfilling Chalmers's requirements of course but most importantly to generate a tangible outcome for the company Epiroc. Indeed, our objective was to create results or proposal that are actually useful for the company and which they can implement or use after we are gone in June. Prioritizing this approach makes the Master's thesis project much more interesting and relevant for both the company and Chalmers Tekniska Högskola.

The first task of our first work week was to establish a complete time plan for the thesis project. We therefore separated the time according to the visits to the product company in Kalmar and in Essen and the tasks according to major deadlines given by Chalmers. We use a standard Gantt chart to visualize our time planning partly shown in *Figure 9* below.

Figure 9- complete timeline of project designed in a Gantt chart

The above image illustrates the planned visits to both product companies. Due to the fact that the product company in Essen is larger in its structure, product volume and project volume, the periods on site in Essen were established longer than the ones in Kalmar. Furthermore, the fact that the communication with the product company in Kalmar was evaluated as being easier since the office is in the same country as we are made it even more relevant to have extended visits to Essen compared to time spent in Kalmar or Gothenburg.

As mentioned above, we then proceeded to planning tasks according to deadlines given by Chalmers which consisted of peer reviews, final presentation and hand in of final report. The milestones of the projects were established as "Decision on Focus areas" which translates to identifying where should improvement be done in the new product development process and "Solution Prototype First Draft" which represent the proposal of an improved prototyped NPD process on a divisional level. The following image illustrates these milestones and deadlines and their position in time:

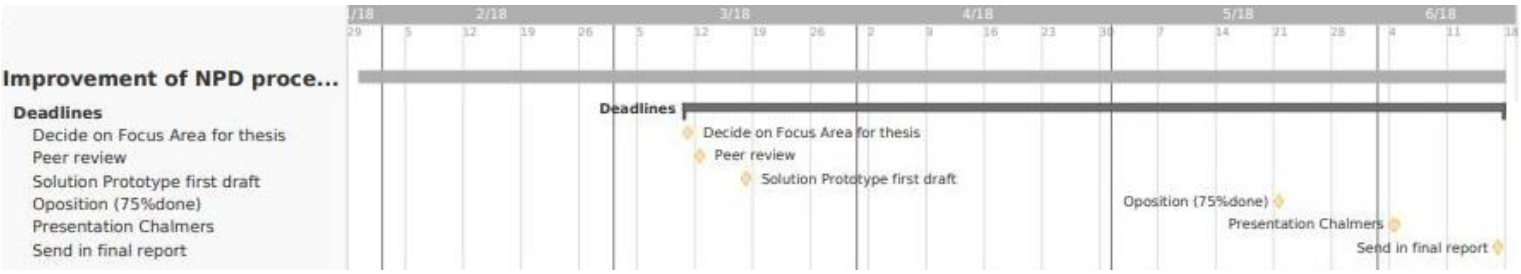

Figure 10- Important deadlines put into the Gantt chart timeplan

From these mandatory deadlines we were able to build a complete approach for the project and thus its timeline. The tasks represented in the approach are thoroughly described all along this research process chapter and are represented in the time plan section below:

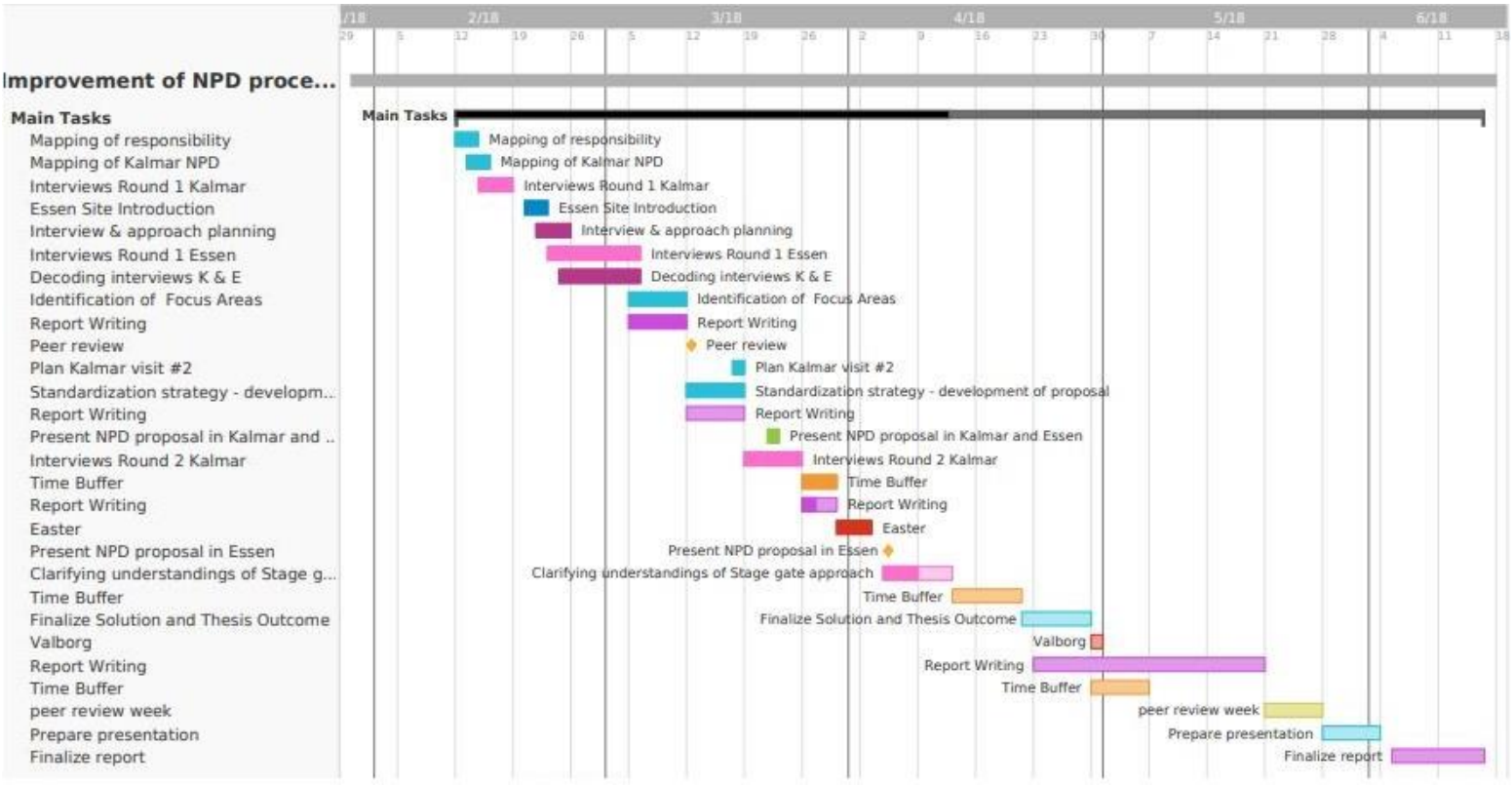

Figure 11- Tasks for the project put into the Gantt chart timpelan

Moreover, the following tables regroups these tasks and gives a short explanation of what they represent in order to give a better overview of why they are needed. Once again, these tasks will be explained more in detail further along this section of the Methodology chapter.

Table 5- explanation of tasks entered in the time plan to complete the thesis

Task	Description
Mapping of responsibility	Identification of the organizational structure: departmental structure, organigrams, project structure for NPDs.
Mapping of Kalmar NPD	Determination of key members and departments involved in NPD process in Kalmar
Interviews Round 1 Kalmar	First series of interviews conducted in Kalmar on all departments involved in the NPD process. The aim of this first round is to gather general knowledge on the current NPD process used and the encountered difficulties it contains.
Essen Site Introduction	Familiarization of the product company in Essen: introduction to facility and its members, introduction to product lines and manufacturing lines, etc.
Interview & approach planning	Adaptation of the interview planning and format to Essen based on the Kalmar one.
Interviews Round 1 Essen	First series of interviews conducted in Essen on all departments involved in the NPD process. The aim of this first round is to gather general knowledge on the current NPD process used and the encountered difficulties it contains.
Decoding interviews K & E	Analysis of information contained and gathered through the interviews in Kalmar and Essen following a precise decoding approach
Identification of Focus Areas	Identification of key problematic areas to improve in the NPD process upon the qualitative data gathered through all interview
Report Writing	Time spent on producing the final report
Plan Kalmar visit #2	Planning of second visit to the Kalmar product company: logistics, presentations and updates, pre
Standardization strategy - development of proposal	Development of first proposal of an improved prototyped NPD process on a divisional level.
Report Writing	Time spent on producing the final report
Present NPD proposal in Kalmar and Essen	Presentation of first proposal for a standardized NPD process and feedback received
Interviews Round 2 Kalmar	Conduction of second round of interviews in Kalmar with each department regarding feedback on the first proposal of standardized NPD process
Report Writing	Time spent on producing the final report

Present NPD proposal in Essen	Presentation of second proposal of standardized NPD process following the feedback received through the second round of interviews in Kalmar
Clarifying understandings of Stage gate approach	Clarification of common understanding of the principals of a stage gate process and its application to the NPD process on a divisional level
Finalize Solution and Thesis Outcome	Final proposal for standardized NPD process following the feedback received in Essen on the second proposal. This represents the final result obtained.
Report Writing	Time spent on producing the final report

In addition to creating the complete project timeline, this first week of work also contained the initial preparation and familiarization to the aspects treated in this project. Firstly, we both revised the final report of the internship in order to be establish a solid foundation to build our thesis on. We then proceeded to revise literature and research primary subjects needed for the preparation of the first visit in Kalmar and for the understanding of the entire perspective of the thesis aim. This literature review therefore concentrated on qualitative study theory, understandings and comparison between different types of interviews (semi-structured, structured, un-structured), qualitative data collection and its analysis by coding. With regards to project management-oriented aspects, we reviewed literature respecting stage gate process, AGILE and Traditional project management methods and risk analysis methods in new product development projects.

The final activity performed in this first week of thesis work is represented by the conception of the interview framework and questions to be used for the first visit and first iteration of interviews in Kalmar. The framework was designed in order to gather general data regarding the NPD process in the product company in Kalmar and to identify the relevant problems and difficulties seen in new development projects. We first started by creating a semi-structured framework which would leave latitude for the interviewee to give his/her own interpretation of the interrogation therefore possibly taking the interview into relevant areas that we had not thought of. The interview framework was therefore divided into steering questions regarding categories of project structure, NPD process, management tools, communication and resource allocation. We further selected members of the organization from all departments involved in Kalmar's NPD process e.g.: Design and Development, Production, Purchasing, Marketing and General Management. Finally, as mentioned above the questions of the semi-structured interview were created to be applicable to all departments as shown in the table below:

Table 6 - Initial questions for semi-structured interviews

	Introduction
1	Name and position?
2	Involved in which project/projects/ Epiroc product line/ AC product line?
3	How long have you worked at AC/Epiroc?
	Structure
4	Within your department, who is your supervisor to and who are you responsible for?
5	How are project structured and managed in your department (mapping structure)?
	New Product Development Process
6	To what extent are you using the NPD-diagram?
7	How and when was it implemented?
8	Have you gotten any education/training about that process?
9	Who/how verifies/ manages that the Stage-Gate process is followed?
10	Are you using the process routines for each process?
11	Which part of the process are you involved in and/or responsible for?
12	How are phase transitions performed (The handover to other department)?
13	Which part/parts that you are involved in are most time consuming/creates the most delay?
14	What is, in your opinion, the biggest problem with the NPD-process as it is today?
	Departments
15	With which other department do you work? for which phase?
16	What is your process from hand in to hand out?
17	Is there a clean Handover from one phase to another or are there deliverables that could be fulfilled by one department or another (possible confusion on who is responsible for it)?
18	For your department, what are the major/most common issues you deal with
19	What interfaces do you use and for what purpose (show ex)?
20	Do you feel like the current interface(s) is functioning well? Why?
21	Are you missing any function or feel like the current interface is not sufficient in any way?
22	Are there any complications/misunderstandings/loss of information due to use of different interfaces?
23	Are there any official risk analysis performed during an NPD?
24	In your opinion, where in the NPD process would risk analysis be most relevant?
25	Why doesn't Kalmar use MS.P?
26	What management tool do you use on projects?
	Communication
27	What is the meeting frequency within your department?
28	Do you have any cross departmental meetings? (ex. for phase transition purposes, simultaneously task)

29	What kind of cross department communication/knowledge transfer are there during the project? (ex design/testing phase)?
30	How and how often do you communicate with:
31	What is your role in the PDC?
32	What is your general opinion of the PDC?
33	How much input can you bring to the PDC?
34	Would you say departments work too much in Cilo ?what is the main reason for this (resources? short on time? etc.) ? what would be a solution for this (cross dep meeting)?
35	In your opinion, what would be the most efficient meeting frequency/ protocole on projects in relation to the phases of the NPD diagram (ex: once a week meetings during the feasibility, less during testing etc…)
	Resource allocation process
36	Who is responsible for the resource allocation on NPDs?
37	When are the resource allocated to the NPDs?
38	Is there a process followed to allocate resources to projects (if so, what is it)?
39	Are resources interchangeable between departments or product line (is it possible for one resource to work on several projects at once)?
40	In your opinion, could resources be better managed within Epiroc and how?
41	Are there and resources exchange between Kalmar and Essen?
	Other
42	If you have worked for another company before Epiroc/AC, how was resource allocation/communication/structure/ management tool/ handled differently and what were the better aspect compared to Epiroc?
43	Can you show us the process for an recently finished/almost finished project? (interface, software, meetings transcripts etc).

First visit to Kalmar Product Company (week 6)

As mentioned above, the first visit to Kalmar served as a first acquisition of qualitative data with regards to the NPD process in place and for the product line held in this product company. As shown also above, the questions prepared were built to determine the problematic areas susceptible to require improvement. The initial step completed when reaching the Kalmar office was to determine the key members of the organization most valuable to be interviewed and schedule interviews with each of them. The selection can be shown in the image below and represent one to two individual from each relevant department. It is important to note that all members of the marketing department are seated in the product company in Essen therefore all interviewed during the Essen first visit described later in this section.

Table 7- Interviewees and respective departments at PC Kalmar

KALMAR	
R&D	VP R&D
	R&D Manager
	R&D Manager
	PM and Design Engineer
	PM and Design Engineer
PROD.	Production Development Manager
	PM and Production Engineer
PURCH.	Purchaisng Manager
GM.	General Manager

The semi-structured interview always began with the signature of a consenting form (see *APPENDIX-A)* given to the interviewee to ensure that all information said during the interview would only be used for our master thesis project. Following the consent, a formal request to record the interview was done in addition to a formal presentation of ourselves, the thesis project and the structure and format of the interview. Only upon the previous steps would we begin the interview which were held by both of us where one was leading the interview, asking the questions and feeding the conversation with the interviewee while the other one took note on a digital document composed of two columns: one with the questions and the other one to write notes and answers. The interviews lasted between 45 minutes to 1 hour in order to not be too long and heavy or take up too much time from the interviewee's day but sufficient enough to gather quality data needed for our project to move forward. Moreover, the person taking notes during the interviews also had the possibility to interact in the conversation if he/she felt more clarifications were needed or if an important aspect was missing. The following figure shows an example of the digital document used during interviews.

Departments

15. With which other department do you work? for which phase?	**Answers or notes from interviewee's answer**
16. What is your process from hand in to hand out?	
17. Is there a clean Handover from one phase to another or are there deliverables that could be fulfilled by one department or another (possible confusion on who is responsible for it)?	
18. For your department, what are the major/most common issues you deal with	

Figure 12- Example of digital document used in interviews

Furthermore, the coding strategy for the interview was establish during this first visit at the Kalmar product company. Indeed, this interview coding approach consisted in taking 30 minutes directly after each interview to go through the notes, recordings and personal thoughts on the answers and discussions had with the interviewee. A three columned table present at the bottom of the same interview digital document was used during the coding to establish and identify the issues and problematic with the current NPD process highlighted by the interviewees. The coding of interview principally consisted of the identification of key issues or problems regarding the current NPD process which we considered as possible areas to build our improvement strategies and answer the research questions. This coding table was later used as a direct data base when doing the statistical analysis of problematic areas to support the identification of these optimizable aspects of the NPD and is presented in the image below:

Questions	Problems	Ideas

Figure 13- Coding table used after each interviews to state all relevant information gathered

As observable in the above figure, the first column was titled "additional questions" and was dedicated to any supplementary questions we might have after reviewing the interview and for which we later would ask the interviewee clarifications on these subjects. The second column titled "key problems" represented the principal data aimed to be acquired through these semi-structured interviews. The information in this column consisted of all mentioned problems encountered in the NPD process by the interviewee and his department and for which we saw a value for improvement thus moving towards fulfilling the aim of the thesis project. Finally, the third column titled "ideas" presented the ideas we had on how to approach these key problems and how to improve the NPD process in order to solve as many key problems as possible.

First visit to Essen Product Company - (week 8)

The first visit to Essen aimed to follow the same research process as for Kalmar, together with creating the first proposal. We were greeted by our supervisors, both

design engineers at the DD department in Essen and then taken on an introduction tour to see the office and meet all employees at the different departments. During the first days the main focus was to get to know the organisation in Germany and the people working there. We got a production tour in the factory where our supervisors explained their production process. Furthermore, they held an introduction of their current NPD process, showing us their logic behind it and the tools they use.

We decided to start interviewing the design engineers at the DD department this first week continuing with the other departments the upcoming week (See *Table 8*). We still did not have company computers, so all interviewees had to be scheduled by asking the interviewees when they had an opening in their schedule, then getting support from our supervisor to book the rooms for the interviews.

Table 8 Interviews round one in Essen

Department	**Position**
Design and Development	D&D Manager
	PM and Design Engineer
	PM and Design Engineer
	PM and Design Engineer
Production	Production Preparation Manager
	Production Logistics
Purchasing	Purchasing Manager
	Strategic Purchaser

Marketing	VP Marketing
	Marketing Manager HAT/CE
	Product Portfolio Manager

Management	General Manager

The same interview structure was used as for Kalmar having one leading the interview and asking the questions and the other taking notes and ask follow-up questions. Moreover, was the same question template used as in Kalmar, with some small modifications of the questions to fit the Essen process. Again, we took turns being the interview leader and note taker. Before the interview started we introduced our selves, the thesis and what this interview would be about. We also informed the interviewee that he or she would be anonymous in our thesis, then asking them to sign our release form to ensure that we were allowed to use the information deriving from this interview in the thesis. Furthermore, we asked if they approved of us recording the interview. After each interview we discussed the findings and did the first coding step where we went through the comments and sorted them into the three columns; *Questions*, *Problems* and *Ideas.* We did this process for all three design engineers the first week.

Interviews and second step of coding (Week 9)
The second week in Essen started with the weekly meeting with our supervisors, where our supervisors helped us identifying the key people at the other departments to interview and to send out requests for the interviews. We still had not received our company computers but managed to get a desk top and together with Sébastien's login details from his summer intern we could start accessing the calendars of the people we wanted to interview, book the interviews, the rooms and access information needed to analyse the NPD process. This week we conducted eight interviews with employees from the other departments and continued with the first coding step.

During this week the next step of coding was started by creating our code book. The creation of the codebook was done by categorizing all stated problems from the interviews and assigning them to problematic categories. These categories contain all problems related to a common issue with regards to the NPD processes in Kalmar and Essen. We also did further research on NPD processes, management techniques and how to induce *AGILE* management into Traditional management processes.

Finalizing Coding and state Key problem Areas (Week 10)
The third week in Essen started with our 12th and final interview. This week the main goal was to finalize the coding of all interviews, the codebook and to find our key problem areas. After completing the final coding for both Kalmar and Essen 12 problematic categories (codes) derived from Essen and 15 for Kalmar (see *Table 9*).

Table 9. First Categorization of stated problems

Color Code	Problematic category
	Marketing commitment
	Deliverables
	Phase in/ Phase out
	Purchasing performance
	Department responsibilities
	Communication Kalmar & Essen
	Risk analysis/Lessons learned
	Communication Cross-Department
	Implementation of NPD
	Project overview
	Feasibility issues
	PDC issues
	PM role
	Delays in testing
	Communication in department

We went through all interviews several times to make sure no comments or issues where missed. If a stated issue would fit into more than one code we decided to add it to all suitable codes. Once we had assigned codes to all stated issues, an analysis was made of the possibility to merge them one step further into fewer, bigger key problem areas. This analysis resulted in 4 final key problem areas; *Resources, Commitment/Involvement, Communication* and *Process structure* (see *Figure 14*).

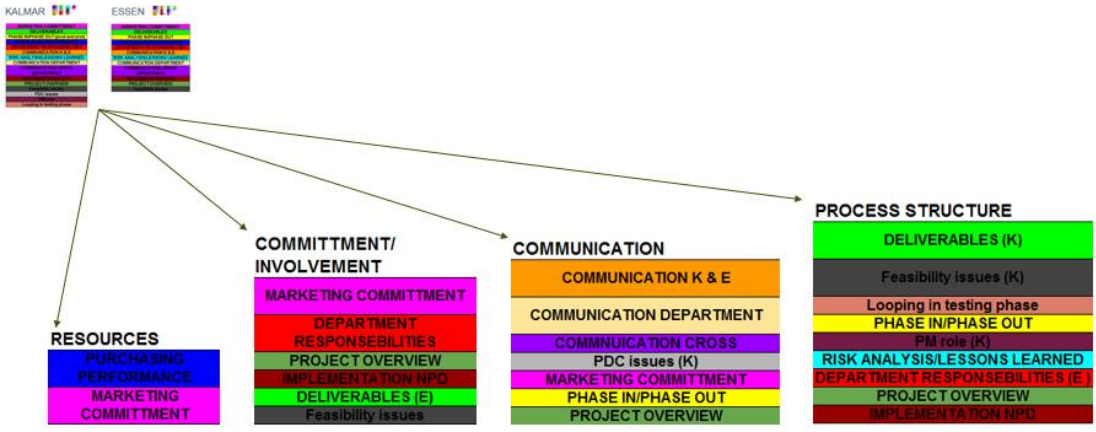

Figure 14. Key Problem Areas

Next step was to create a statistical report to rate these problematic categories. The classification of all problems deriving from interviews was done according to two principal criterions which are described below by variables *a* and *b* as shown below.

$$a = Negative\ impact\ on\ project\ timeline\ (delays)$$

$$a = [1 - 2 - 3 - 4 - 5]$$

Each stated problems has been appointed a grade 1 to 5 based on their impact on the complete project timeline (i.e. the delays created by the stated problem). The variable *a* attributed to each stated problem is presented in the *APPENDIX B*. The variable *b* was defined as follow:

$$b = Number\ of\ departments\ affected\ by\ the\ problem$$

$$b = [(1\ to\ 2)\ dept. - (\ 3+)dept.]$$

The number of affected departments is determined by the first categorization. For example, if issues associated to the "*Marketing Commitment*" category are mentioned by 3 or more departments, the value of *b* is 3+.

Based on the *a* and *b* value associated to each problem, a matrix was built for PC Essen and for PC Kalmar showing the amount of stated problems derived from interviews for each variable:

Table 10. PC Essen Classification Matrix

ESSEN		NEGATIVE IMPACT ON PROJECT TIMELINE	
		UNDESIRABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO PROJECT TIMELINE (0-2)	INTOLERABLE SERIOUS IMPACT ON PROJECT TIMELINE (3-5)
AMOUNT OF DEPARTMENTS AFFECTED BY PROBLEM	3+ DEPT. AFFECTED	3 5 6 7 8 9 10 11 13 14 20 21 31 33 53 58 68 71 83	2 4 12 15 18 19 22 23 24 25 26 27 28 29 30 32 44 45 46 47 48 49 50 51 52 54 55 56 57 59 60 61 62 63 64 65 67 69 70 72 73 74 75 76 77 78 79 80 81 82 85 86 87 88 90 91 92
	1-2 DEPT. AFFECTED	39 42	1 16 17 37 38 40 41 43 84 89

Table 11. PC Kalmar Classification Matrix

KALMAR		NEGATIVE IMPACT ON PROJECT TIMELINE	
		UNDESIRABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO PROJECT TIMELINE (0-2)	INTOLERABLE SERIOUS IMPACT ON PROJECT TIMELINE (3-5)
AMOUNT OF DEPARTMENTS AFFECTED BY PROBLEM	3+ DEPT. AFFECTED	11 12 13 14 18 20 21 24 25 27 74 75 76 77 78 97 98 100 101	1 2 3 4 5 9 10 15 16 17 19 22 23 26 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 50 51 52 53 54 55 56 57 58 59 61 71 72 73 79 80 81 82 83 84 85 88 89 90 91 92 93 94 95 96 99 102 103 104 105
	1-2 DEPT. AFFECTED	7	6 8 46 47 48 49 86 87

The numbers presented in the above Matrixes represent Number IDs associated to each stated problem derived from interviews both for PC Essen (1 to 92 in the Essen matrix) and PC Kalmar (1 to 105 in the Kalmar matrix) (See *APPENDIX B*). As shown in these matrixes, most of the stated problems affect more than 3 departments and are subject to generate negative impact on project timelines. For this statistical analysis, the problems affecting more than 3 departments were considered (blue cells in both matrixes). Problems mentioned by the General Managers were more of overall problems and therefore not precisely oriented on the NPD processes thus will not be considered in the analysis. Furthermore, problems 66 for PC Essen and 60-62 for PC Kalmar were judged irrelevant to this study and were discarded.

By applying the variable *a* and *b* and following the matrix classification as shown in *Table 10* and *11*, graphs where created displaying the quantification of all relevant stated problems with regards to the *First Classification* categories for all departments at both PC Kalmar, PC Essen and finally combining all stated problems for both PC's. The statistics will be used to establish which categories to emphasize on for this thesis and support that the solution will solve the most important problematic categories.

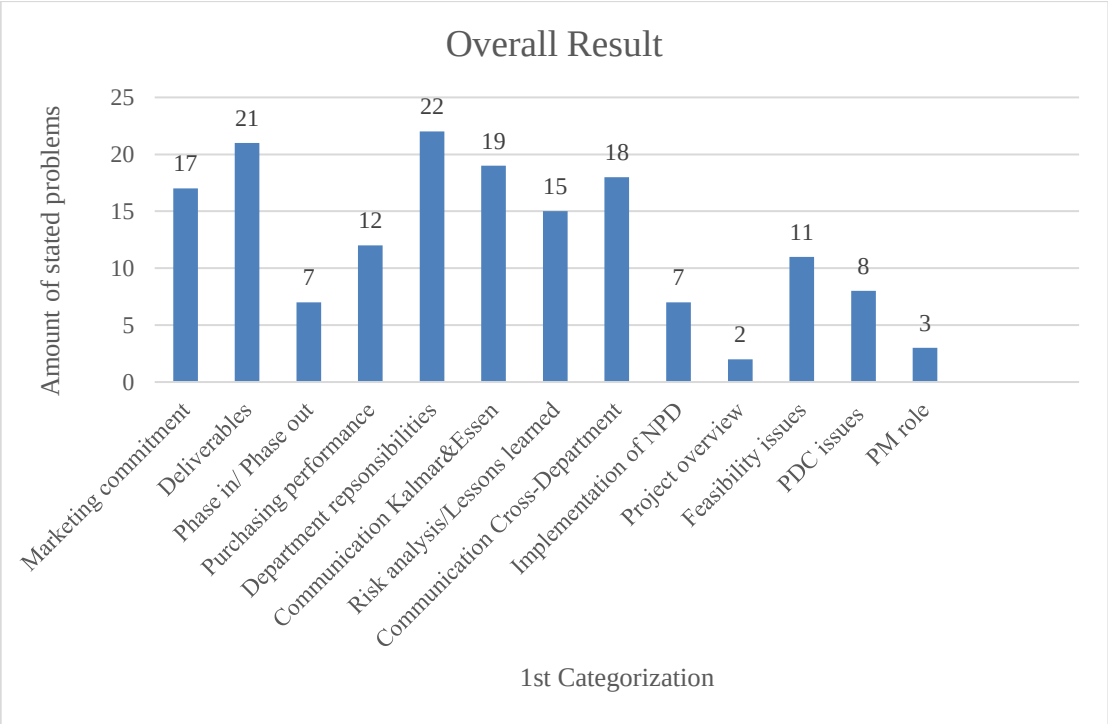

Figure 15. Overall Result for all Dept. from PC Kalmar and PC Essen

As shown in *Figure 15*. *Department responsibilities* and *Deliverables* represent the two problem categories generating most delays and affecting most departments according to the 21 interviews conducted in Essen and Kalmar. This indicates that the results wanted for this thesis should aim at helping reduce the issues generated by the responsibility ambiguities encountered by all departments when going through the NPD processes for the development of new products (see *Figure 16*). The Deliverables of both NPD processes (Essen and Kalmar) shall also be worked on in order to optimize new product development projects. With this in mind, the establishment of a common first level of deliverables for both PC Essen and PC Kalmar will help reduce the deliverables ambiguity and will define clear departmental responsibilities for each deliverable as well as helping with the communication cross-department. Furthermore, this deliverable proposal being common between PC Essen and PC Kalmar will increase the understanding and communication between both PCs. By creating this common thread of deliverables for each phases of the stage gate process, mentioned issues such as *Marketing Commitment* will also be affected positively. This standardized stage-gate process will also function as a foundation for further solution development (see *Figure 16*).

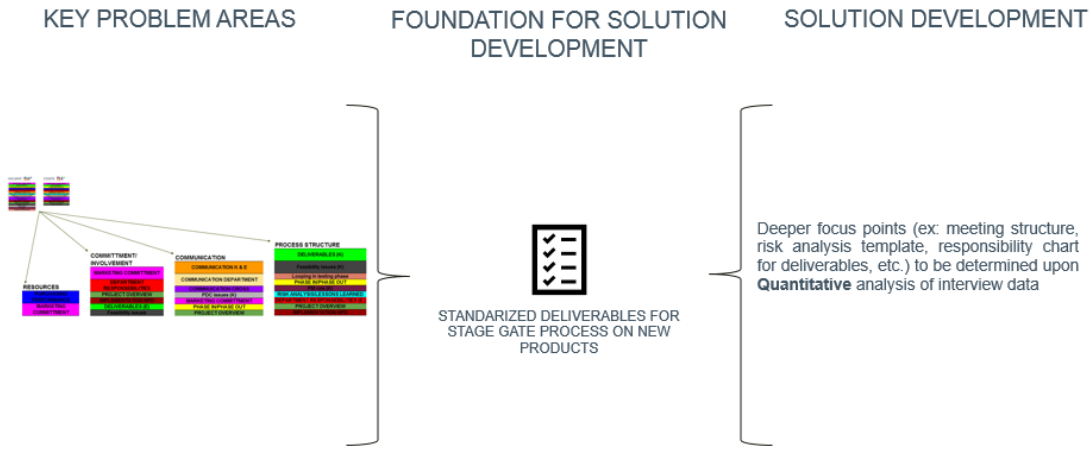

Figure 16. Foundation for solution development

At the end of the final week in Essen the statistics and the suggestion of creating the standardized set of deliverables for PC Kalmar and PC Essen where presented to the supervisors in Essen. It was agreed that this was the right direction to continue with, being supported by the issues derived from the interviews, the statistics and being in line with our desired result of the thesis. The aim and RQ did however need a small modification due to the statistics highlighting the importance of a standardized process. A decision was made to analyse this further to secure a useful proposal at the end. The aim was therefore updated to:

"Identify and propose improvements in the NPD process and related processes by standardizing the NPD process on a divisional level and integrating/improve the risk analysis in this standardized process"

Due to the importance of the standardized process which would solve several of the problem areas, the communication part was eliminated to give more space and time for the standardized proposal. As a consequence the research questions where updated to fit the new aim:

Table 12 - Initial set of research questions

RQ1	What are the main issues with the current NPD process generating the most delays and inefficiencies in projects?
RQ2	What are the main obstacles to standardization of the NPD process between PC Kalmar and PC Essen?
RQ3	How can Risk analysis be the foundation in the projects?
RQ4	What main issues in current process will be improved by standardizing the process on a divisional level?

Finally, we preparations was made for the upcoming peer review meeting where we would present our method, findings and desired result.

Peer review week and creation of first proposal (Week 11)

Peer review was held on Monday where we held a presentation for our two opposition groups. They gave good feedback, especially highlighting the difficulties of working with two different PCs in two different countries and handling the cultural aspects as well as the technical. The rest of the week was dedicated to creating the first proposal of a set of common deliverables for PC Kalmar and PC Essen. We decided to match the deliverables one phase at a time, starting with the first phase, feasibility study phase, and finalize it before moving on to the next phase. At the time, Essen was using an excel file to describe the deliverables and a tick-box showing the responsible department (see *Figure 17*). In order for us to keep control over the various deliverables, we divided the excel list into five separate sheets, one sheet with a list of deliverables for each phase. Furthermore, we added a specific number for each deliverable, starting with *1* for the first one in Feasibility Study phase and ending with *66* for the last one in the Market Launch phase, in this thesis marked with X. Kalmar was using a logic diagram to visualize their deliverables, naming them with a number for the phase and then a number for that deliverable in the logic order ex 1.130, and had colour coded the department responsibilities for each deliverable, portrayed as X.xxx in this thesis (see *Figure 18*).

	A	B	C	D	E	F	G	H	I	J	K	L
1	Main-Deliverables	Deliverables	Comments, examples	D&D	Marketing	CRS	Technical Documentation	Purchase	Production (PC)	Lab	Finance	PDC
2	Feasibility study phase											
3	Project leader: XX											
4	Main Deliverable 1				x							
5		Deliverable			x							
6		Deliverable			x							
7			Comments		x							
8			Comments	x						x		
9			Comments	x	x							
10		Deliverable			x							
11		Deliverable			x							
12		Deliverable			x							
13		Deliverable			x							
14		Deliverable			x							
15			Comments		x							
16			Comments		x							
17			Comments		x							

Figure 17. Example of Essen deliverables in excel list

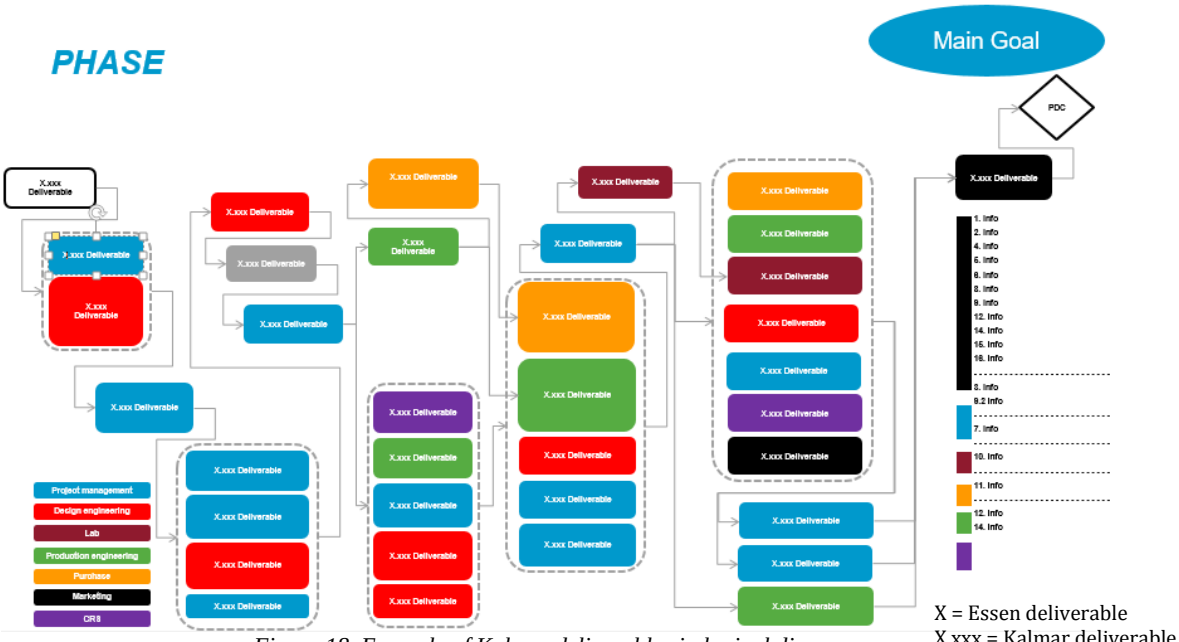

Figure 18. Example of Kalmar deliverables in logical diagram

We started by trying to match the Essen deliverables to the Kalmar ones. After completing the Feasibility study, we noticed that many of the Essen deliverables where possible to match to more than one of the Kalmar deliverables. We therefore took the decision to re-do this phase and connect the Kalmar deliverables to the Essen deliverables. If one deliverable would fit to more than one other deliverable, we matched them to more than one. Due to the many issues stated by the interviews that it was "*too many deliverables*", we tried, if possible, to collapse some of the Kalmar deliverables into one, or merging them under one Essen deliverable. This approach would ensure that all information from the deliverables where still represented in the logic diagram, not as a deliverable but in the routines for the deliverables. We then assigned all deliverables the colour code for the department responsibility, following the Kalmar model (see *Figure 19*).

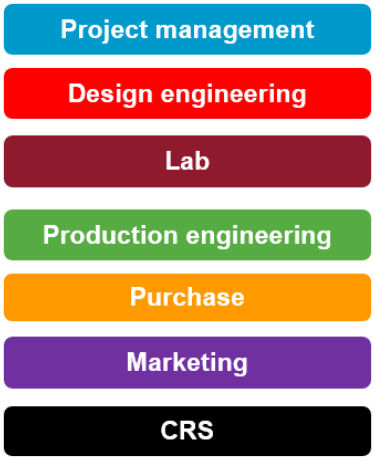

Figure 19. -Colour coding department responsibility

Having this first proposal of matching we added the Essen deliverables into the Kalmar logic diagram. A small circle with the Essen deliverable number was used and attached to the Kalmar deliverables (see *Figure 20*). We then deleted the Kalmar deliverables and expanded the attached Essen deliverables. If the Essen deliverable was represented more than one time it was highlighted with a yellow frame (see *Figure 21*).

Figure 20 - Essen matched to Kalmar deliverable

Figure 21 - Deliverable represented several times

To decide where to put the deliverables which were represented several times, we analysed both the Kalmar logic order form the diagram and the MS project time plan used in Essen. We then cleaned up the logical diagram, only saving one of each

deliverable number (see *Figure 22*). Furthermore, this new logic path was used to create an updated logic path for the Kalmar deliverables (X.xxx), adding the Essen deliverables (X) which we did not manage to match with any of the Kalmar ones and highlighting then with a pink frame (see *Figure 23*).

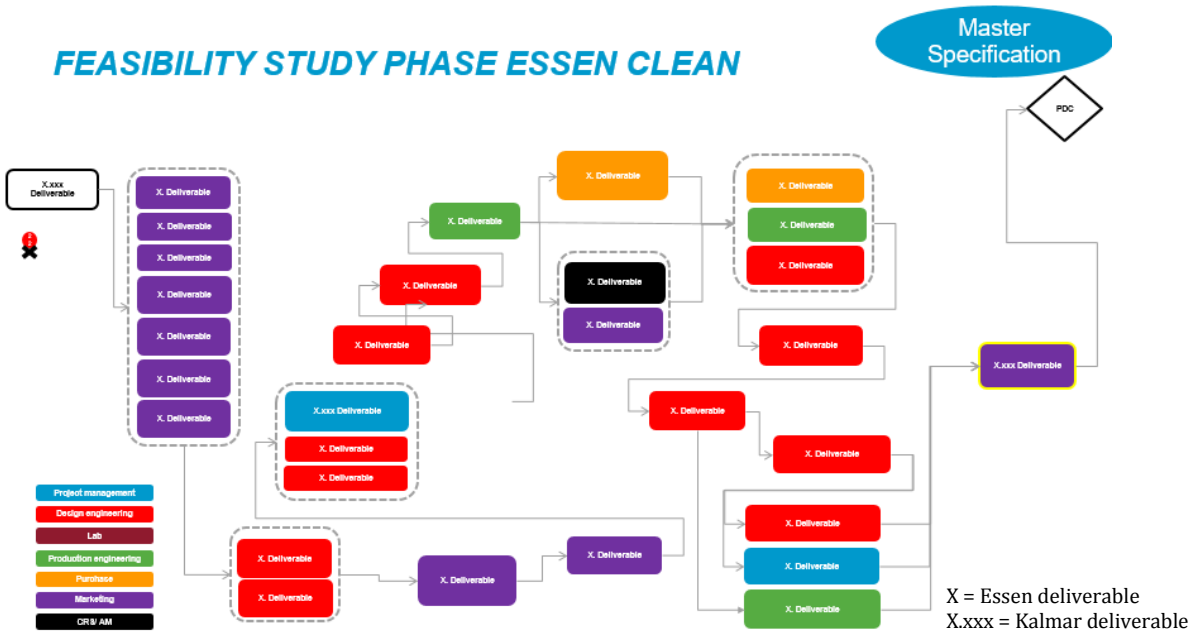

Figure 22. Essen in Kalmar structure, "clean"

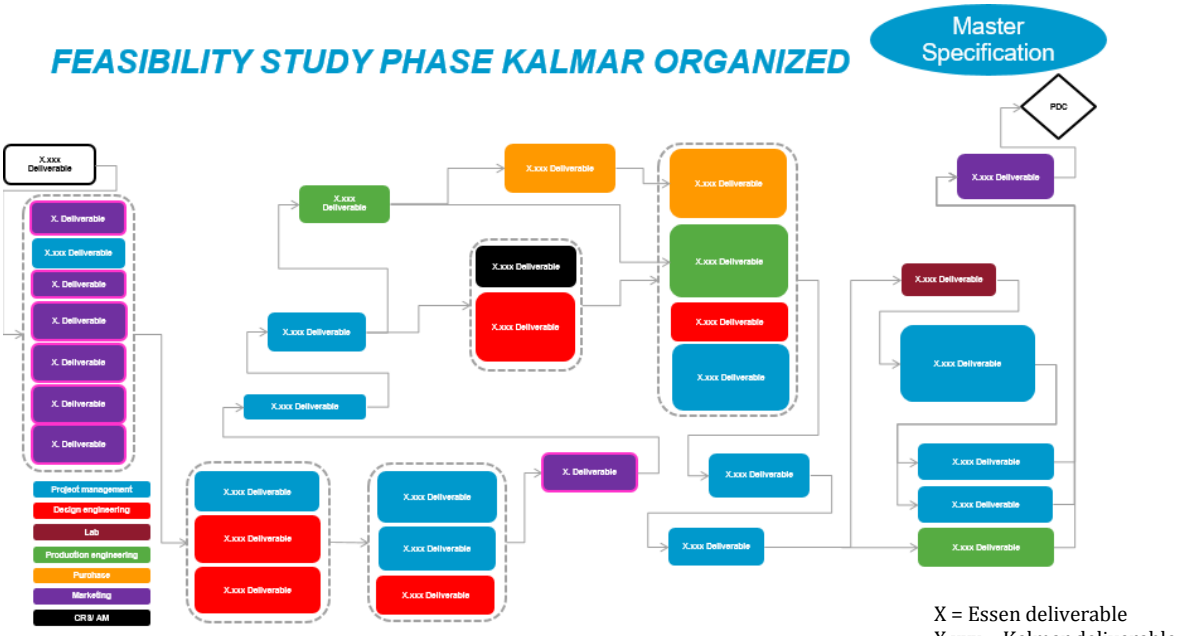

Figure 23. Kalmar in New logic order

The final step was to structure both logical paths, making it easier to compare them both. The final result was two logical paths, one with Essen deliverables (X) adding the Kalmar deliverables (X.xxx) they did not share (see *Figure 24*) and one with Kalmar deliverables adding the Essen deliverables they did not share (see *Figure 25*).

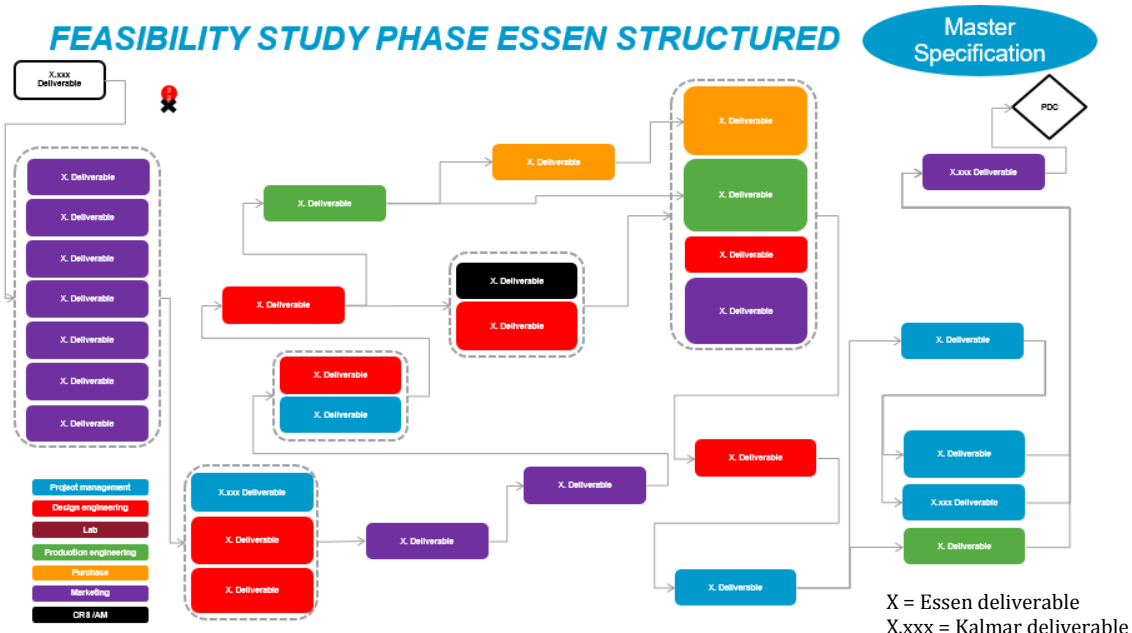

Figure 24. Essen structured

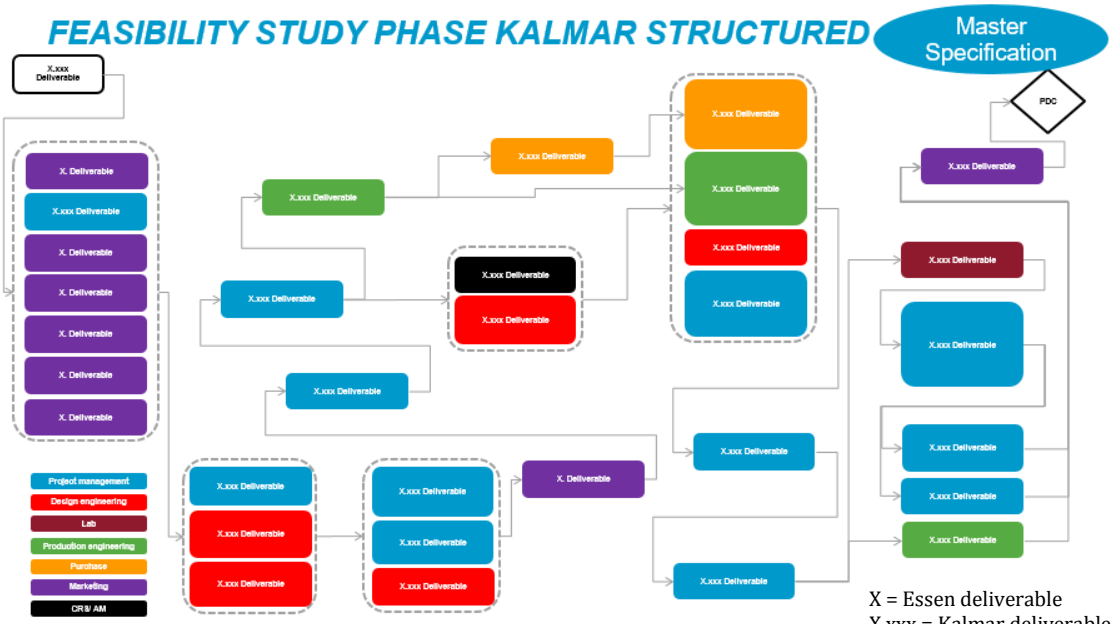

Figure 25. Kalmar structured

When starting the same process for the Design phase the complications started. Again, Kalmar had many more deliverables than Essen, 28 when Essen had 11. We also had trouble matching them to each other. We suspected that something was off and hence did an investigation. After comparing the upcoming four phases we realised that many deliverables where represented in one phase for Kalmar but another for Essen. When analysing it even deeper we noticed a pattern of the Kalmar deliverables; they had a preparation deliverable in the previous phase, a verification deliverable in that current phase and then starting the upcoming phase with a final verification deliverable of the previous phase (see *Figure 26*). Essen on the other hand had most of their deliverables concerning one phase in that particular phase (see *Figure 27*). This is also a big reason to why Kalmar has many more deliverables. They have deliverables for preparation, verification and final verification, where Essen only has one deliverable for it all, giving a deviation of three versus one deliverable.

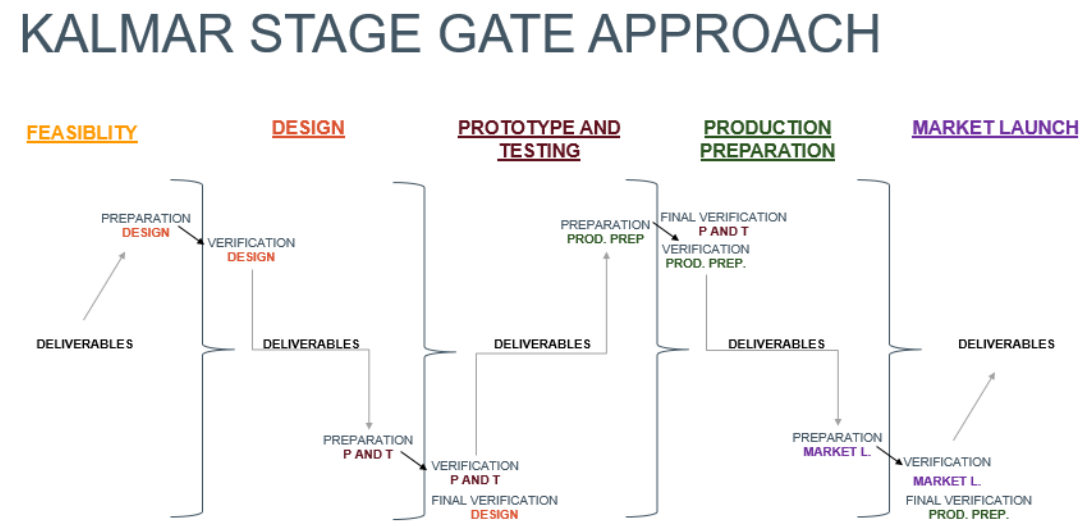

Figure 26. Kalmar stage gate approach

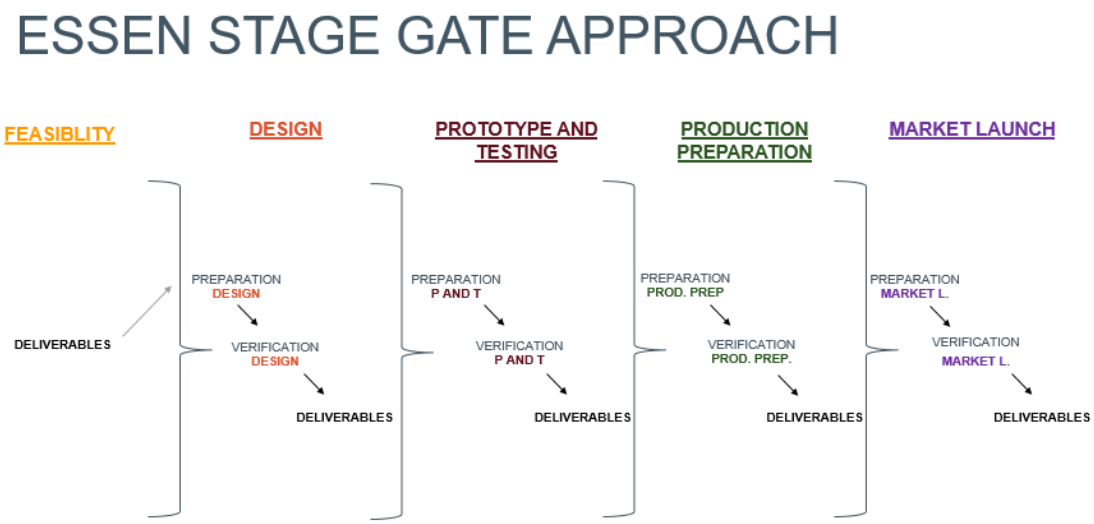

Figure 27. Essen stage gate approach

Further comparison generated the finding that when Kalmar is using their front-loading approach, they put the deliverable very early in the process. Essen is addressing the front-loading by having a more overlapping stage gate process (see *Figure 28*) where they start with deliverables in the next phase before the previous phase is finalized. This indicates that they are, in fact doing the same deliverables at the same time, but that they are placed in different phases for the two PCs.

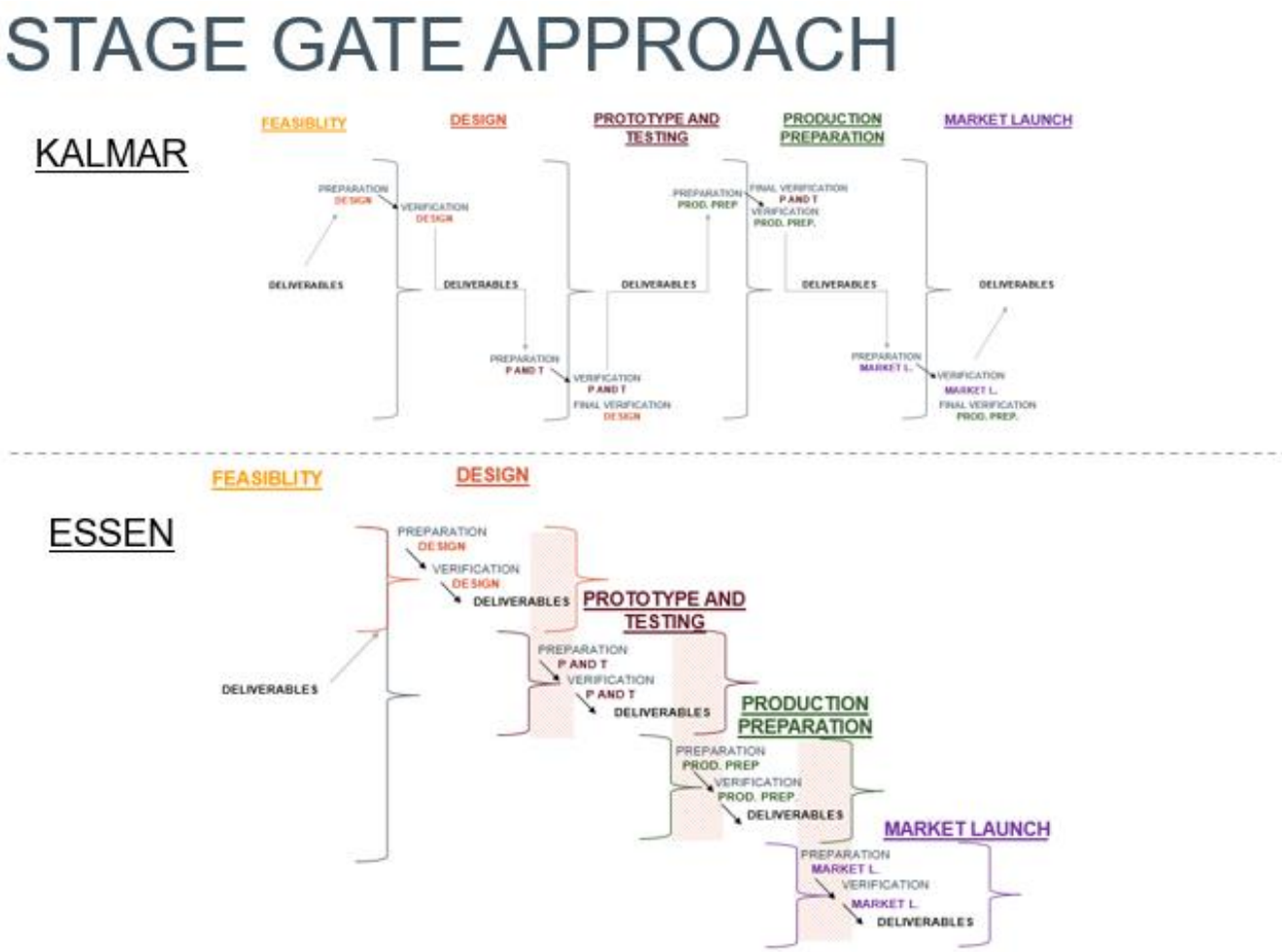

Figure 28. Stage Gate comparison: frontloading vs overlap

After the finding of these different approaches to the stage gate process, together with the deviations in what phase some of the deliverables where placed, a decision was made to do a simpler and less detailed first proposal for the last four phases. This simpler proposal would give room for a deeper analysis, making sure we had enough feedback before making any decisions of moving deliverables from one phase to another or deleting a deliverable. To address these deviations, we highlighted deliverables represented in different phases with a black frame and added a comment in black in the deliverable with the number of the matched deliverable and where it could be found (see *Figure 29*).

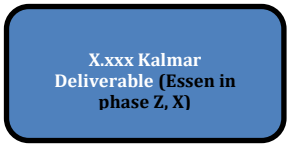

Figure 29. Deliverable matched with another deliverable in previous phase

We continued the same first steps as for the Feasibility study, matching the Kalmar deliverables to Essen, merging and collapsing if possible, highlighting with yellow if represented more than one time and black if it was matched with a deliverable in another phase. If several deliverables where merged into one, the numbers of all deliverables represented was written in white under the final, big deliverable (see *Figure 30*).

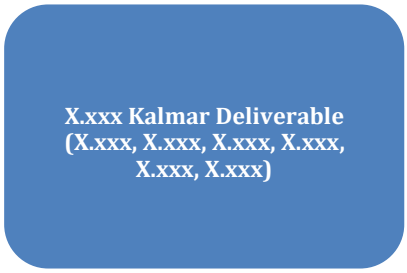

Figure 30. Several deliverables collapsed into one

The final cleaning of the logic diagram was made, again by analysing both Kalmar and Essen logical path and structure. Due to the many deviations for the deliverables in the process and lack of feedback at this stage in the matching process, we decided to use this cleaned up version (see *Figure 31*) as our first proposal and get feedback before doing any of the changes regarding moving a deliverable from one phase to another or deleting one.

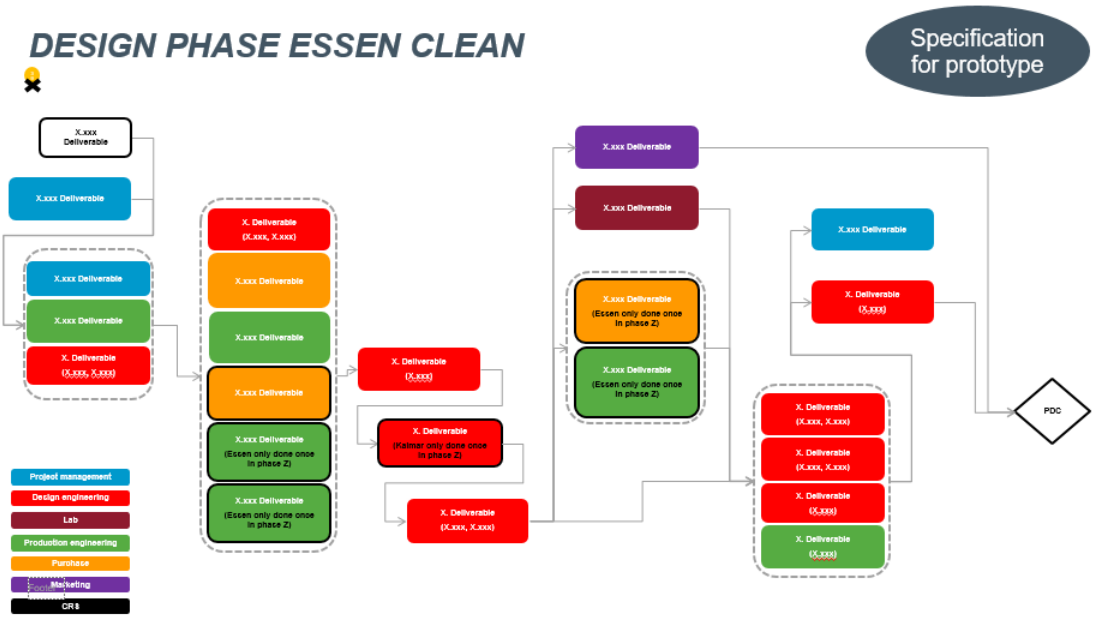

Figure 31. Design phase clean

This process was proceeded for all the last three phases; *Design*, *Prototype & Testing* and *Market Launch*. At the end of this week we had a meeting with one of the creators of the Kalmar logic path diagram for the NPD process. By then we had only finalized the Feasibility study and where trying to find the rout case of the problems in the other phases. The process of the matching and creation of our first proposal for the Feasibility Study phase was presented. We got feedback that we had a good approach, that we seemed to have understood it and that it was an interesting result. This indicated that we were on the right track and further strengthen the possibility to find a common set of deliverables. Furthermore, we had a meeting with our supervisor at Chalmers, presenting what we had done so far with the interviews, coding, problematic categories, key problem areas, the first proposal of a set of common deliverables and the discovery of different approaches to the stage gate process for the two PCs. Again, we received good feedback that we were going in the right directions.

After this feedback and creation of first proposal we made a PowerPoint presentation for next week's feedback sessions. The presentation started with an explanation of the problems derived from our interviews and continued with the matching process and the logic behind our first set of common deliverables. We also explained our discovery of the different stage gate approaches.

Second visit to Kalmar Product Company (week 11)

For the second visit to the Kalmar product company the approach was to conduct feedback sessions with key members of each departments regarding our first proposal for standardized deliverables and the modifications brought to the current NPD. The feedback sessions lasted 1 hour each during which we went through each phases of the standardized deliverable proposal evaluated to improvement made and validating these improvements on a departmental level with each member interviewed. The selection of the interviewee for the feedback session for this first proposal followed the same key members initially interviewed during the first visit in Kalmar with only fewer interviewees per departments in order to work quicker in time.

Additionally to these feedback sessions, we also sent our first proposal for standardized deliverables to each of the above stated members in order for them to look into our proposal on their own and really give us precise feedback on their departmental perspective and on a project overview perspective.

Prior to using the acquired feedback from the Kalmar members, we decided to present this first proposal to our stakeholders in Essen as an update for them to know what to expect prior to our second visit to Germany. During this meeting we encountered difficulties in the interaction and communication of our ideas. Indeed, trying to explain the thinking process used to create the first proposal over an international phone conference without screen sharing or face to face contact ended up highly confusing on both end. The understanding of our proposal and association of Kalmar - Essen existing deliverables was therefore unclear for our stakeholders in Essen which resulted in a refusal of the first proposal and postponage of the update meeting until we came up with a better way to communicate our ideas.

Following this defensive behavior from the Essen product company vis-á-vis our first proposal for standardized deliverables, we decided to adapt our explanation and communication method and started by explaining the different stage gate approaches both product company had with regards to frontloading for Kalmar (doing everything as early as possible in the project) and phases overlapping for Essen (working on two phases simultaneously). This explanation of deviation in basic project management approaches permitted us to increase the knowledge both product companies had of one another's NPD processes. The end of our second visit to Kalmar Product Company thus resulted in a major progress with regards to the knowledge both product companies acquired about one another but also triggered major questioning of logic and disagreement of rationality between Essen and Kalmar, announcing complication for us to bring both NPD processes together on a standardized deliverable proposal.

Steering committee meeting revelation (Week 13)

After having a weekly update meeting with the supervisors in Essen, we managed to clarify some question marks from previous weeks. The routines used for the Kalmar deliverables where in Swedish and therefor Essen struggled to analyse our matching

of the deliverables. Another thing that became clear was how big impact the deviation of understandings of the Stage Gate Process Approach for PC Kalmar and PC Essen. We struggled to understand where the actual deviation was and hence decided to bring it up on upcoming steering committee meeting together with the questions about the Swedish routines for the Kalmar process.

The steering committee meeting was a phone conference with the VP for R&D, the supervisors in Essen, supervisors in Kalmar, the manager for Kalmar and the manager for Essen. Preparations for the meeting was done with questions on how both offices worked with their deliverables and their thought behind where the phase transition was located. This ended up in a big discuss where both offices where trying to convince the other that their way was the best without really giving good information nor listening to the opposite party.

This meeting was somewhat a turning point where both Essen and Kalmar realised how different the understandings of the process seemed to be and our struggle to find a way to merge them. It was also decided by our stakeholders that Google Translate would be used to understand the Swedish routines and that we were to translate them. The rest of this week was dedicated to do research of the stage gate process and trying to analyse both PCs approach with regards to this. The plan was also to translate the routines but we were not able to access them without wifi-connection from the offices and hence this had to wait until upcoming week when we would go to Essen.

Second visit Essen Product Company (Week 14)
The central reason for the second visit to Essen was to get feedback on our proposal and then creating the final proposal by applying feedback from both PC Kalmar and PC Essen. The arrival to Essen would be at the end of the week and hence the first part was dedicated to research and analysis of deliverables. Upon arrival in Essen, it was clarified that the biggest problem with the Stage Gate Approach was the understandings of when a phase transition was to be made, the definition of a deliverable, the acceptance of overlapping phases and the difference of the logical path and the project time plan in MSP together with some other words. A decision was hence made to discuss this on the next weekly meeting with our supervisors in Essen. It was further decided that all routines would not be translated by us and google translate, but by our supervisors when needed.

Essen feedback and Final proposal for Feasibility study phase (Week 15)
The second week in Essen started with a two-hour long meeting together with our supervisors. The main goal of this meeting was to clarify the Kalmar process and what had been done since our last visit. During this meeting a proposal of different levels of deliverables was made to try and handle the different understanding of a deliverable and the resistance from Essen to use them when presenting at PDC. Furthermore, a suggestion to call the deliverables in the Logical path for "Work Packages" was made to handle this deviation of understanding.

The same afternoon we had a phone meeting with the manager in Kalmar and presented the idea of calling them work packages. This was not received well at all. It seemed as both Kalmar and Essen had their very strong opinion and understanding of the word and very protective of it.

After the meeting we had a long discussion and then decided to call the different levels for "Main Deliverables" for each phase which would be what was presented at the PDC in order to move on to the next phase. In order to fulfil these Main deliverables, the "lower level"-deliverables had to be completed. These deliverables would be the same as the ones in the logical path but would also be sorted underneath one of the Main deliverables. The Main deliverables would not be fulfilled until all deliverables belonging to it had been completed.

In order to handle the overlapping, we decided to keep going with previous suggestion to have preparation deliverables for next phase, even though that to an extent oppose the logic behind the phases. These preparation deliverables where to belong to one Main deliverable called "Preparation for upcoming phase". This would secure that all necessary tasks for the upcoming phase, ex ordering raw material, would have been completed upon arrival at the phase transition and PDC.

Furthermore, a decision was made to connect each phase with a number together with a specific number for the deliverable, following the logic from Kalmars logical path. The difference would be that instead of starting at 0.xxx for Feasibility Study Phase it would start with 1.xxx. The Main deliverables would also follow this pattern of numbering where the first Main deliverable for Feasibility Study Phase would be called M1.1 and the first one in the Design Phase would be M2.1 etc.

Once these decisions had been made, we started to go through the feedback emails we had received from Kalmar. They included their opinions of our matching, the new logical path and the possibility to move deliverables existing in different phases for Kalmar and Essen. We also used the first feedback of the matching of the Feasibility study phase received from Essen. An updated proposal, with regards to the feedback from Kalmar, was created and together with an excel list for matched deliverable was sent to Essen for them to analyse and give Feedback on.

In order for us to clarify the deviations of the stage gate process even further, we decided to summarize the words and concepts which seemed to cause the biggest problems and misunderstandings. We sent them to both Essen and Kalmar asking them to explain their understanding of it and give an example of how they used it in their NPD process. The answer was a request to have a meeting with both PCs and have a discussion about the words and concepts in order to create a common understanding and agreement. The meeting was scheduled for the upcoming week were we together with our supervisor in Kalmar (RD Manager), our two supervisors in Essen (Design engineers/PMs and the DD manager in Essen would participate.

Focus-change; from creating a standardized set of deliverables to identify deviations. (Week 15)

The goal for the third week in Essen was to finalize the deliverables and the logical path for all phases, depending on the feedback from Essen which were to be received on Tuesday. During Tuesday's feedback meeting we realized that we and our supervisors had had a different understanding of the purpose of this meeting. They had focused on going through the deliverables, logical order and Main deliverable for the first phase, Feasibility Study phase, in detail and hence had not had enough time to analyze any other phases. The feedback at this point in the study was very much on the details,

where the most difficult task lied in finding the final solution which would work for both PCs. This was, however, a good meeting where we in detail could explain our updated approach and ideas for the final proposal with the different levels. We had also found theory on a Next-Generation Stage Gate model which supported this approach. This model further suggested to implement "conditional go-decision" which allows phase transition even if not all deliverables are completed, but conditionally with documented reasons on why it was not completed together with a person in charge and a plan of how and when to finalize it in the next phase. This input was highly appreciated by our supervisors and worked well with our upcoming proposal.

Another finding brought up on this meeting was the indication that the gates lack "teeth". The current Stage Gate process does not seem to have a strong kill/go/pause-decision making process and lacks criteria to analyze the projects. The supervisors agreed with this and supported the idea that it might be worth looking into if possible. It was then agreed that the supervisors would mainly focus on checking the Deliverables and the Logical diagram in order for us to create the Main deliverables once the foundation in the model was set. The final four phases were much more complicated than the first due to the deviation in Stage Gate approach, logic thinking, overlapping and process, thus needed a deeper analysis with bigger changes before a common set of deliverables could be agreed. Furthermore, a decision had to be made on how to handle the deliverables existing in different phases for the two PCs. Those deliverables were one of the main obstacles for us not being to create the Main deliverable-level for the final phases.

The feedback from this meeting was then used to finalize the first phase, Feasibility study phase, on all levels creating the final proposal. In order to make it bullet proof, we once again sent it back to Kalmar for approval.
Whilst waiting for the feedback regarding the final four phases, an updated report-writing schedule was created. All chapters and paragraphs, except analysis and conclusion, were divided equally between the two co-writers, and included set deadlines for when the different sections had to be finalized.

The concept discussion meeting was held on Thursday morning with all participants from Essen gathered in a conference room and the Manager from Kalmar calling in. There were seven words/concept which would be discussed:

- Deliverables
- Stage gate process
- Project time plan
- Logic Diagram
- Phase transition
- Frontloading
- Reporting at PDC

The meeting started very well with both PCs explaining their understanding of deliverables followed by a discussion. It was then agreed that the two levels for the Stage Gate process were to be called "Main deliverables" and "Deliverables". We also got approval from both PCs to have these two levels, with the input that the Main

deliverables should focus on important criteria for the PDC with regards to Kill/Go/Pause-decisions.

The second concept, the Stage Gate process, also started in a good manner but changed radically once we started to go into details. The discussion highlighted many deviations between the two PCs, both in actual processes but also mindsets. At this point we stopped following the list of concept and started to discuss the process in general. After 30 minutes of discussions not leading anywhere, a break was held where the participants from Essen could talk among themselves and coming to an agreement from their side. When returning to the meeting, a request was made by Essen to postpone this discussion until the day after. The Manager for DD wanted to take an hour and analyze the effect of adapting a more Kalmar way to their process, having big activities divided into two smaller ones in order to separate the phases and avoid overlapping in the time plan.

The postponing of this matter was agreed and then continued by the discussion about frontloading. We got confirmation of what we had suspected, Kalmar was using a strong frontloading approach where deliverables had been moved to earlier phases and Essen was handling frontloading by overlapping their phases. Activities seemed to be performed at approximately the same time for the projects at both PCs, but due to the different approach on where to place the actual deliverables, the process looked very different. We also discussed cost and realized that the two PCs does cost allocation in a different matter. This was also to be discussed further on the meeting the next day, depending on the outcome after the Essen Managers analysis.

After the concept meeting, we had a meeting with our Essen supervisors. The big question was if the standardization would actually be possible after the findings of existing constrains. A new discussion regarding the deviations in the processes and the effects it had was held, deriving a proposal to change focus for the final on-site week. Instead of trying to create the logical diagram with common deliverables, the focus should be to clearly state the differences between the two PCs and what had to be solved before a standardized Stage Gate model would be possible.

The postponed concept meeting was held on Friday and again highlighted the deviations between the processes at PC Kalmar and PC Essen. After discussing the constrain and the time limit a decision was finally made to follow the proposal from the day before. The goal now was to get the Feasibility Study phase approved and agreed by both offices, on both the Main deliverable level, the deliverable and the logical diagram. This could then be used as a template/framework on how to create the final four phases once the existing deviations and constrains had been solved/agreed upon between PC Kalmar and PC Essen. The focus was thus moved from trying to complete the logical path with agreed deliverables and Main deliverables for all phases, to concentrate on identify and explain the deviations.

Final modification of aim of the Master thesis (week 17)

Following the meeting involving stakeholders from both product companies described above, a clarification meeting was held between us and our supervisors at the Essen product company. This meeting took place early during our final week on site in Essen and aimed at the reorientation of the Thesis focus, thus another modification of the aim due to our findings. During the meeting, it was agreed that deviations in the

organizational foundation and structure were too important for an NPD process to be standardized on a divisional level in the current circumstances. Indeed, it was recognized and agreed by the stakeholders that the current differences in resource allocation processes (cost, human resource planning, ERP systems) and in departmental and project manager responsibility had to be precedently addressed before a standardization of complete NPD proceed can be possible between the two product companies. Furthermore, current disagreements on stage gate process understanding, phase transition position and overlapping of phases were pointed out as being related and caused by the above mentioned structural deviations therefore also inhibiting the standardization of the NPD process anteriorly to attending to these deviations. This meeting thus led to the modification of the aim into the presentation of a complete NPD process *proposal*, for which only the *feasibility study* phase would be agreed upon by both product companies, supported by the explanation of current deviations and their caused disagreements making the standardization impossible for us as we do not have decisional power, knowledge and/or time to modify functioning structures of both product companies. The modified aim, representing the outcome of this meeting is as followed:

"Identify and propose improvements for the NPD process at Epiroc by standardizing the project management process for new product development on a divisional level."

The final research questions were also thus established in order to fulfil this final aim and are as below:
RQ1: What are the main issues with the current NPD process at Epiroc generating the most delays and inefficiencies in projects?

RQ2: What are the main obstacles to standardization of the NPD process between PC Kalmar and PC Essen?

RQ3: What is needed before a standardization of the NPD process at Epiroc HAT divison is possible on a divisional level?

Still during this final week in Essen, we proceeded to hold a meeting with the Essen stakeholders to thoroughly define the deviations and disagreements prohibiting the standardization of the NPD processes. We covered in details the current situation at the product company in Essen with regards to the following deviations and disagreements:

- Overlapping as opposed to Frontloading
- Cost allocation
- ERP system (use of SAP)
- Respect of process theory
- Deviation in project manager role
- Position of gate transition

The clarification and reasoning for these disagreements and deviations thus represented parts of our results and half the justification of "why" we were unable to completely standardize the NPD processes between both product companies in the current situation. The objective was to conduct a similar explicative meeting with the product company in Kalmar to complete the acquisition of our results.

The last activity conducted in the product company in Essen was a closing meeting as we were going back to Sweden and not returning to Essen for the remainder of this thesis. This closing meeting had for outcome to update all stakeholders in Essen on the final and current aim of the thesis, the obtained results and what was next to come in the weeks preceding the finalization of the master thesis. All modification of aim and desired/obtainable results were agreed upon and acknowledgment were made.

3.3 Research Strategy

The following chapter contains theory on used methods in the research process.

3.3.1 Interview Methods

The acquisition of qualitative data represents the basis of result generation for research areas in which numbers and quantities cannot be derived and used as references to support arguments. Indeed, qualitative data is most commonly acquired through interviews conducted on a selected sample of individuals representing the population affected by the research topic. Gill et al (2008, p.291) presents that there are "three fundamental types of research interviews: structured, semi structured and unstructured". Furthermore, each interview approach used in each type of interview varies depending on the desired spectrum of qualitative information to acquire (DiCicco-Bloom, Crabtree, 2006). Qualitative interviews have the purpose to "explore the views, experiences, beliefs and/or motivations of individuals on specific matters [and are] most appropriate where little is already known about the study phenomenon or where detailed insights are required from individual participants" (Gill et al., 2008, p.292). These aspects therefore justify the diversity in styles and approaches used within the three main types. For the scope of this research, only semi-structured interviews will be studied.

Semi Structured Interviews

According to DiCicco-Bloom & Crabtree (2006), semi-structured interviews are defined as "in-depth interview, which seeks to foster learning about individual experiences and perspectives on a given set of issues" (DiCicco-Bloom & Crabtree, 2006, p.314). Furthermore, authors argue that semi-structured interviews represent the most popular approach for qualitative data acquisition in qualitative research and consist of open questions purposely steering the interview towards desired aspects but leaving space for divergence of testimonies and dialogues with the interviewees possibly leading to unforeseen useful information. Moreover, DiCicco-Bloom & Crabtree (2006) further state that semi structured interview permits researchers to improve the current questioning or add subsequent question when new valuable information arises from interviews. The relation built during a semi-structured interview between researchers and interviewees is of the utmost importance in order to establish trust and comfort in the interaction leading to the generation of high-value qualitative data.

The development of a semi-structured interview prior to data acquisition is also crucial. Gill et al. (2008) present essential aspects to be considered in the development of semi-structured interview framework. All interviewees must be informed about the general topic of the research and interview as well as its scheduling to allow preparation. Furthermore, Gill et al. (2008) also give attention to the listening abilities researchers must possess when conducting semi-structured interviews in order to limit the need for

repetition and interruption of conversation flow. Finally, with regards to the establishment of a semi-structured interview, DiCicco-Bloom & Crabtree (2006) suggest the selection of a homogeneous sample of interviewees with the most direct exposure and interaction with the studied topic or issue to acquire tangible data.

3.3.2 Data Analysis Theory for Qualitative Data

Analysis of qualitative data is a challenging process (Clissett, 2008) and should according to DiCicco-Bloom and Crabtree (2006) occur concurrently with the data collection. There is no universally accepted method for this type of data summary and analysis, but at its simplest it is described as a process to create a coherent scheme by clustering together related types of narratives. According to DeCuir-Gunby et al. (2011, p.137), "analysing interview data is a multistep ''sense-making'' endeavour" where it is important to engage in the process of coding data in order to make sense of the interviews.

Codes, Codebook and Coding

Even though there is no universally accepted method for analysing qualitative data, most qualitative researchers emphasise the importance of creating and using a codebook since it is seen as the most critical step of the process (DeCuir-Gunby et al., 2011). How to create this codebook is widely discussed and described by various authors, all with a unique approach and set of steps.

The most common initial step of analysing interview data is to develop *codes* (DeCuir-Gunby et al., 2011). Codes can be defined as ''tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study'' (DeCuir-Gunby et al., 2011, p.137). The codes can be seen as a category assigned with pieces of data, most commonly phrases, sentences or paragraphs that are connected to a specific context or setting. Developing codes is an iterative process where the most commonly described strategies are Theory-driven, Data-Driven or a combination of the two. Theory-driven codes are developed from existing concepts and theories anterior to the interviews where the researchers are required to constantly revisit the used theories. Data-driven codes on the other hand emerge from the raw data during the interviews and demands that this raw data is repeatedly examined.

The guide to help analysing interview data, the codebook, consists of a set of codes, examples and definitions and is fundamental as it serves as a formalized operationalization of the codes (DeCuir-Gunby et al., 2011). The codebook is used for organizing the codes after the raw data has been coded and assigned the correct code. The coding process is done to reduce and simplify the raw data and should be an integral part of the data analysis process. Coding also allows the researcher to expand its data by finding new relations between concepts, to transform the data by converting the raw data into relevant blocks and reconceptualise the data by re-investigate theoretical correlations. The core of coding is a circular process in which the researchers use theoretical findings and current research, as shown in *Figure 32* below.

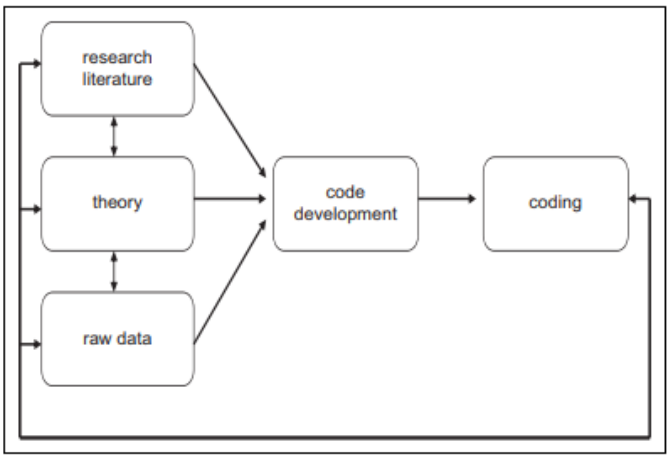

Figure 32. Circular process of coding (DeCuir-Gunby et al., 2011, p139)

Framework Method

A method which is becoming increasingly popular due to its systematic and flexible approach to analysing qualitative data is the Framework Method (Gale et al., 2013). This method is further recommended to be appropriate for novice research teams which do not have extensive experience of conducting qualitative research. It was developed in the late 1980's by researchers Jane Ritchie and Liz Spencer Qualitative Research Unit at the National Centre for Social Research in the United Kingdom. It was first developed for large-scale policy research but is now used widely in various other fields. The method has no specific epistemological, theoretical or philosophical approach, it is an adaptable tool with the possibility to fit into a great deal of qualitative approaches which are aiming to generate themes. Furthermore, the tool itself is not dedicated to the inductive, neither deductive, thematic analysis. It is rather decided and adapted by the researchers and depends on the research questions. Its distinguishing feature is the matrix output with rows (cases), columns (codes) and summarised data collected in cells. This provides the researches with a structure which systematically reduce data and the option to analyse it both by case and by code. The Framework method is most commonly used for the analysis of semi-structured interviews but could be adapted to other types of data as well. The method consists of seven stages:

1. Transcription
   The documentation of the interview data is called transcription. It is important to record the interviews in order to go back and listen to them once again if needed and to document the answers. The Framework method does not demand a complete written documentation of the entire interview word-to-word, which can be difficult to read due to people talking at the same time or pauses but is rather interested in the content (Gale et al., 2013).

2. Familiarisation with the interview
   It is important to become familiar with the whole interview, especially in multi-disciplinary or large research projects. It can be of interest to re-listening to the audio recording and or re-reading the interview transcripts. Another suggestion is to use one margin to record analytical notes, thoughts or impressions. This stage is particularly important for projects where the ones conducting and transcribing the interviews are not the same as the ones analysing the data (Gale et al., 2013).

3. Coding
   In this stage the researchers read through the transcript and apply a code (paraphrase, label etc) of what they found important in that specific passage. Codes could be specified on substantive things (specific behaviours, incidents or structures), values (which inform or locate certain statements choice), emotions (anger, frustration, appreciation) etc. The codes can be pre-defined by exiting theories or explicit focus areas for the project, which is more suitable for a deductive approach, while it is possible to jump straight into indexing if it is an inductive study. It can, however, be useful to do some open coding for deductive studies as well as the pre-defined coding, to make sure that important data is not unnoticed. The aim of coding is to classify all data in order to compare it systematically with other units of data. It is important to look outside the unexpected when performing inductive coding, this includes getting a holistic impression of what was said together with the standard coding line-by-line (Gale et al., 2013).

4. Developing a working analytical framework
   All involved researchers should participate when creating the framework. The development should start after a few transcripts have been coded with labels, which are then compared, discussed and finally a set of agreed set of codes are decided. This agreed set of codes is the working analytical framework to be applied to all subsequent transcripts where the codes can be merged together into categories, for example by using a tree diagram. It is possible that new codes will arise as the coding goes on which then have to be applied to previously coded interviews. A highly recommended suggestion is to have an "other"-category to avoid ignoring data that does not fit in. The final analytical framework is done once the last transcript has been coded (Gale et al., 2013).

5. Applying the analytical framework
   Once the working analytical framework is created, subsequent transcripts should be indexed by using the developed categories and codes. It is suggested to assign each code a number or abbreviation for quick identification (Gale et al., 2013).

6. Charting data into the framework matrix
   In order to manage and analyse the great volume of data acquired in qualitative studies (15-30 pages from one-hour interview) it is vital to be able to summarize and reduce it. The Framework method creates a matrix by using a spreadsheet to map the acquired data and summarize it into categories. It is essential to find the balance between data reduction without losing the original meaning or "feeling" from the interviewee. The risk of this can be reduced by including references to interesting or illustrative quotes into the chart. When the members or the team has agreed on and are familiar with the analytical framework and have practiced the coding and charting, it should take approximately half a day per hour-long transcript. However, it is important to take into consideration that it takes longer in beginning (Gale et al., 2013).

7. Interpreting the data
   It is suggested to take notes of early ideas and interpretations in a book or computer file. By discussing these, characteristics of and differences between the data are gradually identified which can generate possible typologies, interrogating

theoretical connections (emerging from the data or from already existing concepts). It also helps exploring the relations and/or causalities by mapping the connections between categories. If the acquired data is extensive enough, it can generate findings beyond the description of specific cases, such as predicting the most likely response from a specific social actor in or to identify fields or functions which are not functioning properly within a system or an organisation. This stage often takes longer time than anticipated. This is therefore important take into consideration, allowing sufficient time for meetings and analysis in the project plan (Gale et al., 2013).

3.4 Evaluation of Quality

The following section justify the credibility of this thesis, analysing the research process by applying the concepts related to research method and research strategy.

Qualitative research

For a research in which the main objective is to identify unknown issues and problematic in an existing process, qualitative data represents the most accurate research strategy. Indeed, such an investigation requires the questioning of the closest actors to such process interacting with it on a daily basis. Qualitative research as opposed to quantitative research therefore provides data drawn from actual practical experience which gives a thorough proximity to the matter at hand (Auerbach et al. 2003). Furthermore, "qualitative research allows for naturalistic observation and description, rather than testing general laws" (Auerbach et al., 2003, p.29) which collides with the hereby thesis objective therefore validating the authenticity of this research method.

Furthermore, an abductive research strategy is consistent with the definition of qualitative research as it provides the most accurate hypothesis possible in the current situation or until other better explained hypothesises are developed (Kok Ong, 2012). Moreover, the concept of systematic combining in abductive strategy presented by Dubois & Gadde (2002) permits the constant development and re-orientation of the study depending on the progressive findings and hypothesis generation. For a thesis such as this one for which knowledge of key issue areas in the NPD process has to be developed, the ability provided by the systematic combining approach to perform "back and forth" motion between practical observations and researched theory (Dubois & Gadde, 2002).

Finally, the triangulation of data relates directly to the authenticity of this research as it represents a data validation method (Flick et al., 2004). Given the nature of this master thesis taking place with two divisional entitys, triangulation of data represents a core part of the analysis of new product development processes in the sense that both processes are compared to each other to generate the thesis outcome. Furthermore, triangulation of data also permits the comparison of acquired qualitative data from different sources in this project e.g: all involved departments in each respective new product development process of the two studied product company thus supporting once again the credibility of the hereby method.

Interview methods

With regards to the selection of semi-structured interviews as a method of qualitative data acquisition, the nature of the investigation done in this thesis for which hypothesis and key problem areas of current development processes have to be determined called for the use of semi-structured interviews . Indeed, semi-structured interviews permits the evaluation of unforeseen information by letting the interviewee engage freely and in an unrestricted manner in a dialogue (Gill et al., 2008) which therefore allows investigation of more than one precise aspect given a thesis scope such as this one which stands in the identification of issues with the current NPD processes and proposal of improvement. Once again, semi-structured interviews represent the most accurate qualitative data acquisition method therefore justifying the integrity of the here by research and method.

Data Analysis and Coding

The structure and process of the Framework method present the possibility to effortlessly compare data within individual as well as across cases (Gale et al., 2013). This type of freely comparing and contrasting data are essential for qualitative data analysis. The method provides clear steps which are easy to follow with highly structured outputs of data. It is thus particularly useful in projects with several researchers where not all members have experience of qualitative data analysis, or for managing large data sets with the aim to obtain a holistic, descriptive overview of the entire set of data, as for the process in this thesis. Furthermore, the possibility to adapt this method to the specific study depending on the interview questions, regardless of it is deductive or inductive, is an advantage (Gale et al., 2013). This created a possibility for the researchers in this thesis to change direction depending on the results derived from the interviews, going from being a inductive study in the beginning, with the scope inducing where to focus, then evolving to a more deductive approach in the end to continuously investigate the hypothesis.

On the other hand, Gale et al. (2013) explain that "the Framework Method cannot accommodate highly heterogeneous data, i.e. data must cover similar topics or key issues so that it is possible to categorize it" which can be seen as a disadvantage. This was, however, not a disadvantage for this thesis since the data collected was with regards to one topic; establishing the strengths and weaknesses for the current processes for both offices. The coding for both PCs was then easy to compare, creating the possibility to find common issues and strengths and what the both PCs could contribute to support the other.

To ensure quality in qualitative research is a somehow troublesome issue (Charmaz, 2006; Lincoln, 1995 & Seale, 1999). It is essential to take into consideration that the analysis process is not purely technical but influenced by the researchers performing it. It is therefore important to keep in mind that the researchers may have different backgrounds, characteristics, critical reflections and experiences of the topic which could affect the outcome of the coding and interpretation of data. This is a possible input for this thesis, with two novice researches from different countries, adding the fact some interviews where held at a third country.

The number of interviews held at both PCs, including all departments involved in the NPD process, on levels from engineers to general managers and VP, together with the statistic report created to analyse the data, further supports that this is a trustworthy

study. Finally, the extensive research done before this qualitative data study further supports the trustworthiness of this paper.

Ethical

Four ethical issues where considered related to the interview process:

1. Each interview was started by an introduction of ourselves and informing the interviewee about the background of the master thesis, the structure of the interview and what the information would be used for, creating a safe environment.
2. All participants was asked to sign a release form to secure that we are allowed to use contained information and for the interviewee to be able to consider the answers.
3. All interviewees where asked permission to be recorded, explaining that the record would only be used by the researchers to do the coding of the interviews, securing that no important information was missed.
4. The interviewees where informed that they would be anonymous to prevent the risk of exploitation.

Furthermore, one issue was considered related to the process of this thesis.

5. Due to the structure of a joint thesis having both Kalmar and Essen as equal stakeholders, the researchers have been aiming for an objective study, highlighting the importance of not favoring any of the PCs. The objectiveness was also taken into consideration when performing the interviews. Furthermore, the researchers have aimed to keep both PCs equally updated and involved in the process.

4 EMPIRICAL

The following chapter represents the description of current process used in both product companies respectively with regards to new product development processes used on project. The description is objective and drawn from collected qualitative data through interviews and observation of processes.

4.1 Epiroc Product Company in Essen

This subsection describes the general process used in the Epiroc unit in Essen with regards to new product development process.

4.1.1 Project Structure Essen

The following section describes the structure of projects conducted at the product company in Essen with regards to new product development.

Decision making/ authority/ Organization culture

The current NPD process in Essen involves principally four departments: Design and Development (DD), production, purchasing and marketing. The DD department drive the new product development project in its entirety as the project managers are design engineers. Production and purchasing play key roles in the process with regards to producibility and acquisition of all needed materials/manufactured parts to bring projects to completion. The marketing department is a divisional department as it acts on all units of the HAT division although being seated in Essen. Furthermore, the marketing department initiates projects as they bring input from the market which are later translates to the new product development projects. Production department and purchasing department are involved in new product development projects but also with serial production of the entire product line already on the market which calls for division of resource time between new product development and serial production with prioritisation of serial production as it represents the source of revenue for the product company. In addition, a fifth department is involved in new product development projects on a secondary level as they are responsible for technical documentation. Although not studied in this research, the technical documentation department is seated in Essen with their manager located in Kalmar. Moreover, the departmental structure consist of, for the four NPD involved departments, the core team and their manager. Divisional higher management is also seated at the Epiroc unit in Essen at the exception of the Vice president for research and development whom is located at the product company in Kalmar. *Figure 33* below shows an organigram for each of the four above mentioned departments and the role of each member of the core team along with departmental managers.

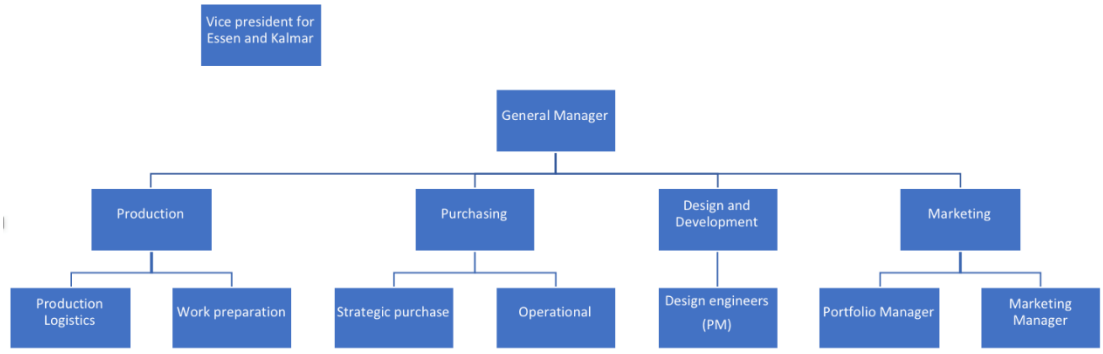

Figure 33 - Organigram of departments in PC Essen

In addition, Project managers for new product development projects are design engineer from the DD department. All new product projects are driven from the DD department in which design engineers occupy both the role of project managers and design responsibles. The project managers are therefore responsible for the complete feasibility study phase and design phase and for monitoring and controlling the entire project from start to market entry.

Stage gate process

The new product development process in place at the product company in Essen follows a stage gate process introduced by the Vice President of research and development. It is composed of the five same phases for all units of the HAT division which are: Feasibility study, Design, Prototype and Testing, Production preparation and Market launch. All phases technically have gates which are represented by the Product Development Council (PDC) meeting occurring on a monthly basis. These PDC meeting have for role to give the "Go", "Pause" or "Kill" status on projects transitioning from one phase to another but currently also act as update meetings in which issues are brought up to the division and potential solutions are discussed. The PDC is composed of managers from DD departments currently working on new product development as well as divisional Vice Presidents and or divisional President occasionally. The meetings are hosted by the Vice President for research and development who acts as the gate keeper and who has decisional power on project statuses. Possible involvement of other department managers in the PDC meeting occurs when issues with their departmental responsibility need to be explained further. Furthermore, each phases have deliverables which are currently proper to each Product company respectively and which will be explained further below. All deliverables from each phases are to be completed before transitioning to the next phases with current possibility to transition with conditional approval upon unfulfilled deliverables from previous phase granted a justification is given and approved by the PDC. The outcome of each phases is however the same on a divisional level.

Stage Gate Approach

The product company in Essen sees its full budget for project approved after the feasibility study phase. From that point the approach is to complete deliverables and involve resources as early as possible to avoid any delays of higher costs. In order to do so, the Epiroc unit in Essen uses overlapping of phases for particular long lead deliverables such as ordering raw materials or external manufacturing of parts. *Figure*

34 below displays an example of a time plan used in Essen for which clear overlapping of all phases after feasibility study.

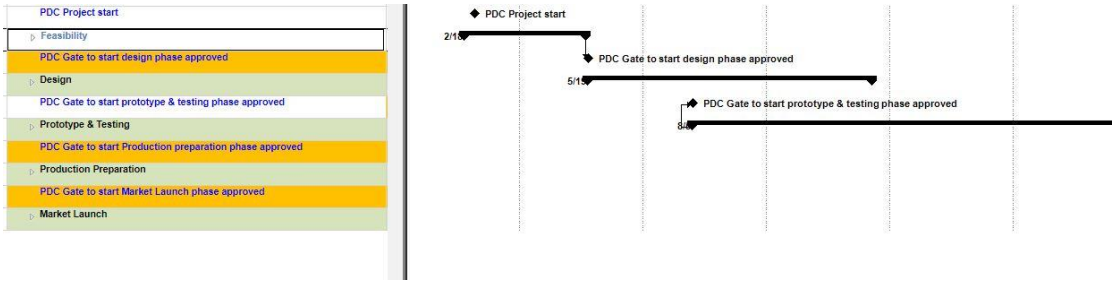

Figure 34- Example of overlapping phases in Essen's timeplan

With this approach, the product company in Essen asks for phase transition at the PDC prior to large investment (large use of budget) such as the deliverables mentioned above. As there is an overlapping of phases, the phase transition is normally approved at the PDC upon conditional completion of the remaining deliverables from the previous phase. This overlapping approach is also used in order to adapt to the occurrence of PDC meetings as they take place monthly and are not adapted to each project time plan. In this sense, conditional phase transition is done to avoid any delays waiting for the next PDC meeting. The project duration depends to the product developed and the nature of the project. For the product company in Essen, new product development project consisting of up-sizing or downsizing of already existing product see an average duration of 24 months whereas completely new product development sees an average of 12 to 24 months depending on the product type as said.

Deliverables, KPIs and Routines

The Design and Development department in Essen follows a list of deliverables associated to each phases. These deliverables are proper to the DD department and its project managers and consist of the results of activities completed in the previous phase. A complete projects counts 66 deliverables divided unequally over the five phases of the stage gate process and are shown in *Figure 35* below:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Main-Deliverables	Deliverables	Comments, examples	D&D	Marketing	CRS	Technical Documentation	Purchase	Production (PC)	Lab	Finance	PDC
2	**Feasibility study phase**											
3	**Project leader: XX**											
4	**Main Deliverable 1**				x							
5		**Deliverable**			x							
6		**Deliverable**			x							
7			Comments		x							
8			Comments	x						x		
9			Comments	x	x							
10		**Deliverable**			x							
11		**Deliverable**			x							
12		**Deliverable**			x							
13		**Deliverable**			x							
14		**Deliverable**			x							
15			Comments		x							
16			Comments		x							
17			Comments		x							

Figure 35 - example of deliverable list used for phases of the stage gate process

From this image, it is observable that each deliverable is composed of activities needed to be completed in order to fulfil said deliverables. Furthermore, the deliverables are used to provide key information and project progress to PDC meetings in order to make project status decisions at the process's gates. The desired outcome of each phases can also be seen as one major deliverable per phase. Indeed, each phase has a desired outcome which is shared through all divisional NPD processes and are shown in *Table 13*:

Table 13- Outcome of each phases of the stage gate process

Phase of Stage gate process	Outcome of phases
Feasibility Study Phase	Master Specification
Design Phase	Specification for prototype
Prototype and Testing Phase	Approved Design
Production Preparation Phase	Product approved for serial production
Market Launch Phase	Serial production and sales

Deliverables are also used as Key performance indicators. Indeed, throughout the project, deliverables regarding update of project timeline, update of product cost and budget and update on deviation from initial requirements are the main KPIs reported to managers and to the PDC meetings. These KPIs are also key aspects considered for the approval of phase transition.

Finally, the DD department at the Essen product company has produced a descriptive list of their deliverables made available to all departments but the deliverables remain a tool only used by the project managers and an example of deliverable description for the feasibility study phase is shown in *Figure 36*. No numbering or identification system is in place to identify the deliverables, the names and the phases they are associated with act as their identification.

Deliverable	Definition
Feasibility (Product Portfolio process)	
Verification of technical requirements	Plausibility check of Marketing requirements, e.g. preliminary calculations and simulations
Legal requirements analyzed	Inquiry of domestic and foreign laws and regulations concerning their influence on the product, e.g. safety and health requirements, environmental requirements, ccc-certificate etc.
Application analysis made	Visits of construction sites and customers to gain impression of market requirements, specifics, work environment and work conditions to verify marketing requirements
Patent search made	Preliminary patent search based on marketing requirements to analyze “state of the art”, e.g. new technology and innovations in order to detect and avoid conflicts with existing patents at an early development stage
Preliminary project risk analysis	All criteria that can influence the success of a project, e.g. costs, delivery time, design risks etc.
Preliminary design completed	Feasibility check of Marketing and CRS requirements, e.g. preliminary product design, preliminary design of service tools, customer experience analysis, competitor product analysis etc.

Figure 36 - Description of deliverables for part of the feasibility study phase

Department involvement

As mentioned earlier, four departments play key roles in a new product development at the product company in Essen. The projects are driven by the project managers from the DD department whom request involvement of all three other departments (Production, Purchasing and Marketing) upon the initial resource planning done during the feasibility study phase. These other department therefore provide input on what resources they have available for such a project and can thus include said new product development project into their own departmental schedule whilst, once again, always

prioritizing serial production. The Marketing department initiates the demands for new product development projects which requires a significant involvement during the feasibility study phase and during the market launch phase.

4.1.2 Communication Essen

The following section describe the communication channels and methods currently implemented in Essen to generate a project information flow.

Meeting structure and frequency

All most common meetings conducted at the product company in Essen are listed below

Project meetings

For the Design and Development department at the Epiroc unit in Essen, the meetings are held in accordance to the project manager and departmental manager needs. Indeed, there is no official meeting structure and it is left to the discretion of each project manager to gather his or her DD team members (other designers, draftsman/draftwomen, etc.) to hold an update meeting. Similarly, meetings between project managers and the departmental manager are held generally every week depending on the project situation and in which phase it currently is with no official structure. These meetings normally occur to inform about changes in projects or issues recently occurring and get a quick solution or mitigation. Moreover, daily interaction within the department acts as a mean for information flow. For instance, when technicians or designers have questions for the project manager they reach out to them with no need for a formal meeting. Similar situation is seen between project managers to reach out for help or inquiries about resources and or project management insights.

Cross departmental communication

Communication between departments and between functions involved in new product development projects are explained below.

PDC

As mentioned earlier in this report, the Project Development Council takes place on a monthly basis and serves as the decisional meeting to approve, cancel or put on pause a project requiring phase transition based on the fulfilment of deliverables and its accuracy with regards to initial requirements, time plan and budgeting. According to interviews conducted at the product company in Essen, the PDC meetings are of high importance for divisional management and project management as they gather several departments and all product companies of the HAT division of Epiroc. The PDCs are hosted by the Vice President for research and development located in Kalmar and occurs through a digital platform named “Webex” for which a presentation including all projects is shared amongst the attendees and project updates or phase transitions are requested and decided upon.

Prototype meeting

The prototype meetings are held once a week and involve the DD project manager and the production department. This meetings serves as a constant interaction during the prototype and testing phase to discuss the functionalities and producibility of the created design. Through these meetings, issues from the production and manufacturing lines are brought up and iterations in design can be done based on these communications. The prototype meetings also concern the matching of scheduling

between serial production and new product development and also leads to discussion with regards to the phasing in and phasing out from prototyping to pre-serial production. The prototype meetings frequency comes to an end when the new product development projects transitions from prototype and testing phase to production preparation phase.

Escalation meeting
The escalation meeting occur every day at the product company in Essen. This meeting as for purpose to gather daily issues from all departments at the start of each day form their managers which then meet with the General Manager of the Product Company and decide on possible solutions for said issues. Once decisions are made, the information is brought down the departmental structure where the issues arose and the process repeats itself every day.

Project summary meeting
The project summary meeting occurs once a month and involves all departments. For this meeting, all projects and departmental progress or activities must be reported in a presentation. During this meeting, all departments discuss upcoming events, general productibility, current issues and forward planning. These meeting permits all departments to align their situation together to increase efficiency of the product company and gather perspective of each departments all together.

Product portfolio meeting
The new product idea meeting is held once every second year also gathering all departments and treats of the possibilities of new product development for the product company. During this meeting, the marketing department shares input from the market and the current trends from the competitors. From this ideas of new product can be brain stormed which further generates new project for the DD department.

Inner divisional communication
The communication between the product company in Essen and the one in Kalmar is mostly based on the interactions occurring during the PDC meetings. On a higher managerial level the two parties have more exchange of information with regards to divisional goals and controlling of revenues and resources which is not specifically related to new product development and therefore not studied in this research. With regards to new product development project, the communication is almost inexistent at the exception of requests or inquiries directed at the Vice President of research and development. This lack of communication between the two products companies will be shown in the statistical analysis presented in the empirical analysis chapter of this report. As both product companies use different processes for developing new product and as these product lines are also divergent, the need to communicate more than for phase transition or divisional decision making is not seen as a priority.

Inner divisional collaboration
As mentioned, the differences in processes currently used for developing new product hinders the possibilities of collaborations between the two product companies in Essen and Kalmar. Furthermore, there is no concrete history of product development collaboration between these parties and there is no foreseen initiative to engage in such exchange.

4.1.3 Management tools Essen

Interface and software

With regards to interfaces and software used for the purposes of new product development in the product company in Essen, several are used to fulfil different tasks in a project. *Table 14* below shows all currently used software.

Table 14 - Interfaces and softwares used at PC Essen

Lotus notes	Old storage/data base still used to a certain extent. Will be replaced by Share-point in the future.
MS Project	Project monitoring and planning software used by all Project managers at the Product company in Essen.
Gibraltar	Project overview tool to get an overall perspective of all running projects. Mainly used by the Vice President for research and development.
Windchill / PDM-Link	Used by Design engineers to release their drawings and make them accessible to other department for use.
Office 365	Used by all employees for email, calendar, booking meetings etc.
Jabber-Webex	Used by all for Virtual meetings, ex PDC. And internal conversation interface (chat room)
Sharepoint	Future storage/database, currently used to a small extent but to be used on a divisional level in the future
SAP	ERP system in use for cost and other resource allocation. Accessible by all departments at the product company in Essen and interacting with the MS Project software for project management

With regards to project management tools, the MS Project software represent the principal project management interface to monitor project time plan, budget and deliverables. Indeed, for all new product development project project managers use a MS Project template which includes the DD deliverables for each phases. Other project specific deliverables and activities are further added by each project manager in their respective MS Project templates. The software permits also the comparison of actual costs and budget with the initially planned budget and costs which further serves as a basis for presenting the KPIs at the PDC meetings. *Figure 37* displays a typical example of an MS Project interface used by project managers for new product development at the Essen product company.

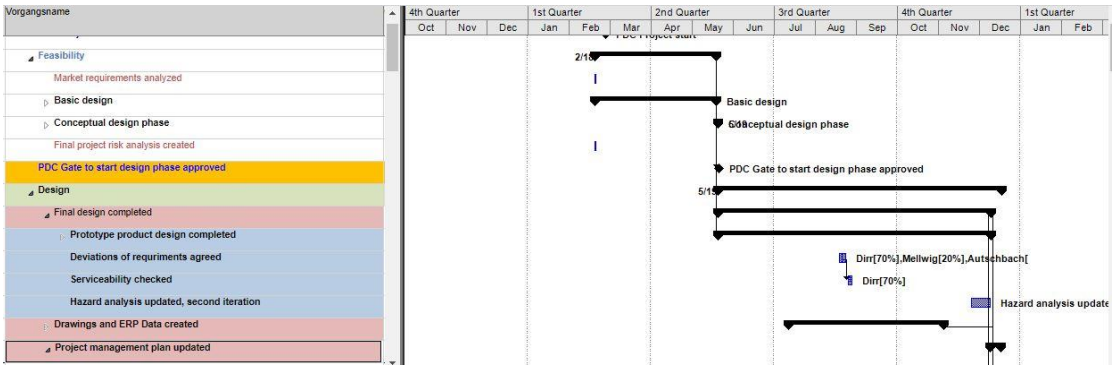

Figure 37 - Image of a typical MSProject template used for time and budget controlling by Project Managers at PC Essen

Risk analysis structure

From a technical point of view, the product company in Essen performs three iterations of risk analysis on the product itself. Indeed, as part of the deliverables in feasibility study phase, design phase and prototype and testing phase an iterative hazard analysis including product safety review, transportation, life-time cycle etc. This iterative process if finally completed at the beginning of the market launch phase prior to the market entry of the final product. With regards to project risk analysis, a project risk analysis is created during the feasibility study phase and updated at the end of each subsequent phases prior to phase transition request to the PDC. Although well established as a deliverable, there is no official structure or more thorough analysis then simple verification of several check points such as stock availability for production, verification of design by production team prior to manufacturing start, etc. which consist mostly of damage control rather than foreseeing of possible problems. Moreover, according to the conducted interviews at the product company in Essen no documents or records are produced for this risk analysis. It was also mentioned that the implementation of a more structured risk analysis had not been successful in the past as the interpretation of risk and their impact varied from one individual to another.

4.1.4 Resource allocation process Essen

The resource allocation process currently implemented in Essen for new product development is described in this section.

Project resource allocation

With regards to resource allocation in projects, all required resources are assigned during the feasibility study for the entire project after receiving the input from marketing generating the demand for a project and prior to receiving approval to move to design phase. Project managers are appointed by the manager of the DD department depending on their current work load, experience and product line of expertise. Furthermore, budget is to be approved upon the calculation of product cost (PK), time and other resources. An estimation of desired PK based on desired competitive selling price and profit margin is giving during the feasibility study by the marketing department after which project managers estimate the PK as well based on technicalities and producibility trying to match as much as possible the marketing desired PK. Upon approval of the budget, project managers include said budget into the MS Project interface dividing it between all phases of the stage gate process. This will further allow project managers to monitor the costs of their new product development project. When

establishing the initial budgeting of a project, all departments involved are requested to provide estimation of human resource time needed to complete such project which is then transferred into costs. This estimation of time and budget therefore permits all departments to adapt their respective schedule in accordance to the approved time plan. The project budget, PKs and project time plan is featured in the master specification document and presented for approval at the PDC meeting prior to official start of said project.

During the project, labour hours and product related costs (ex: raw materials) spent by all departments on a new product development project are entered into the ERP system (SAP) by the project managers. All costs related to a specific project are allocated to a project account in the ERP system under different categories. Project related costs are allocated per each phases in accordance to the deliverables generating the cost. If there is an overlap in phases, cost generated by an overlapped deliverables are allocated to the phase to which the deliverables belongs even if phase transition has conditionally occurred.

Total budget and time plan for new product development projects are updated at the end of each phases and compared to the initial estimation to evaluate deviations. These deviations must be reported to the PDC prior to phase transition and/or to indicate delays or higher costs. To insure accuracy in time planning, the project managers from the DD department will ask managers from the other involved department updates on their initial time estimation when getting closer to their involvement as considerable time might have gone by between the initial feasibility study phase and the beginning of certain departments' activities.

Resource exchange between Essen and Kalmar

In the current new product development process situation there is no resource exchange or knowledge shared between the two product companies studied in this research. It is however important to mention that a new resource has been added to the marketing department as a project portfolio manager for the HAT division. This position has for purpose to overview new product development projects throughout the division which thus represent a shared resource between the Epiroc unit in Kalmar and the one in Essen. As this new member of the organization has only been in function since January 2018, the analysis of his impact on new product development project as a product company common resource could not be studied in this thesis.

4.2 Epiroc Product Company in Kalmar

Following is a description of PC Kalmar, one of the three PC's for the HAT division at Epiroc.

4.2.1 Project Structure Kalmar

This subsection describes the general process used at the Kalmar unit with regards to the new product development process.

Decision making/authority/Organisation structure

There are three departments located at the PC Kalmar which relate to New Product Development; Research and Development (RD), Purchasing and Production. The Marketing department is situated in Essen and is the same for PC Kalmar and PC Essen. Furthermore, the Vice President (VP) for RD, is also based in Kalmar. Each department has one or more managers, who are also reporting to the PC's General Manager, see *Figure 38*. The Project Manager is a design engineer during the first three phases and it is then handed over to a production engineer to be the PM for the final two phases. The decision to change the PM role was made a few years ago due to complications for project management when NPD projects was held for products produced in factories in other countries. Having a PM close to the factory once the production started was considered an advantage. This reason was further supported for products produced in Kalmar, where the production engineers are more experienced and close to manufacturing in the daily work, hence more skilled to manage the final two phases. The decision to change project managers after three phases was also considered to increase department responsibility from production at an early stage in the project.

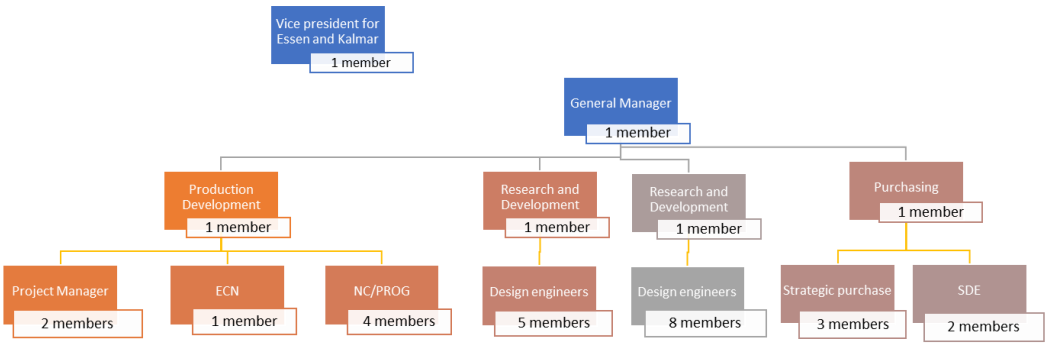

Figure 38. Organigram Kalmar

Stage gate process

The innovation model used at Kalmar PC is a Stage Gate model with five phases; Feasibility Study Phase, Design Phase, Prototype and Testing Phase, Production Preparation Phase and Market Launch Phase. Each phase has a main deliverable or goal to reach, as seen in *Figure 39.* After each phase a meeting is held called PDC (Project Decision Council) where decisions on how to proceed with the project are done. This meeting is managed by the VP RD but also attended by top management. This meeting function as the Gates for the project, and the VP DD, or the president if present, are the gate keepers deciding the future for the projects. The PMs are giving an update for the projects, and request for a phase transition if the deliverables for previous phase are fulfilled. Requests for ordering material or other costs can also be done at this meeting. A logical path diagram is used as the NPD structure tool which includes several Deliverables to be achieved for each phase (see *Figure 39*). The logical diagram is limited to one A3 per phase and state the latest time a task has to be finalized, when to start is to be decided in the time plan. This logical diagram was developed 2016, after PC Kalmar had had an audit and needed to improve the NPD process. The logical diagram was implemented in January 2017 and has since then been updated twice. There has not been any big projects going through the entire current NPD process yet. One important aspect for the process in Kalmar is frontloading, meaning that things should be done as early as possible and bringing in resources as early as possible with the aim to shorten the project lead time (time-to-market) and minimize the risk for delay. There are currently no NPD projects running at PC Kalmar.

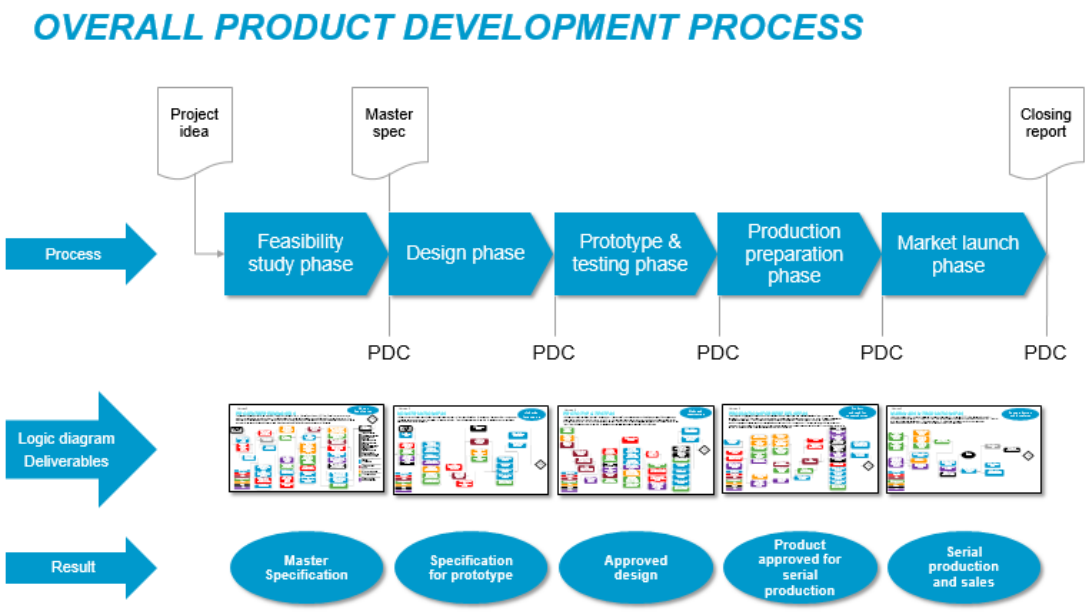

Figure 39. Logical diagram explanation: Product development process and logical diagram

Stage Gate Approach

Kalmar has a Stage Gate approach where the budget and time plan are approved in the beginning of a project, after feasibility. The phase transitions are placed when all the deliverables needed to deliver the main deliverable are done and do not consider where the costs are located through the project. There are no strict criteria, but the status for the deliverables are reported, why they may not have been fulfilled and how they are to be mitigated. Due to the frontloading approach, some deliverables have been moved to an earlier phase, and function as preparation deliverables. The upcoming phase has verification deliverables which confirms that the needed activities have been done. There is no overlapping of phases and all deliverables in a phase should be done before going to PDC and asking for approval to move to the next phase. However, some exceptions are made for the activities in the time plan which needs to be overlapped due to long lead time. The average time for NPD project is 12-24 months. It is not uncommon that some of the deliverables are not completed when reaching a PDC due to the fact that PDCs is occurring once a month and are not planned depending on when phase transitions are to be performed for the projects. Phase transitions can be approved even there are some unfulfilled deliverables at the time for PDC, but with the remaining deliverables for the current phase to be "conditionally approved" and done in the upcoming phase. PC Kalmar has a strong understanding of the importance of NPD projects but the serial production should always be favored. Best practice is highly integrated which makes PC Kalmar very flexible to change.

Deliverables, KPI's and Routines

There is a total of 157 deliverables in the Kalmar process, divided into the five phases. Each phase is given a number, starting with feasibility study phase (nr. 0) and ending with market launch (nr 4). The deliverables are then given a specific number which are then increasing with 10 for the upcoming deliverable, ex first deliverable in feasibility study phase is 0.010 and the last one in market launch is 4.170. The 10 numbers in between each deliverable creates the flexibility to ad deliverables in the future without having to re-name them all. One example is deliverable 1.127 which was added after the process was created. There deliverables are not rated nor prioritized in any way. Each deliverable in the logic diagram has a written routine which are saved in a folder system, following the same logic as the logic diagram, where the routine has the same name and number as the deliverable. The routine describes what is needed in order to complete the deliverable, who is in charge and how it should be documented. The documents produced to complete the deliverables are saved in another folder system, again following the same logic as the logic diagram. The deliverables describe what has to be done in each phase to reach the Stage Goal and hence move to the next Phase. The logic diagram describe the latest a deliverable has to be done, but when to start it is described in the project plan/time plan. The most important KPI for PC Kalmar are "On time delivery" and "Lead time deviation".

Department involvement

Each department has been assigned a specific colour which are then applied into the logic diagram. The deliverable has the same colour as the department responsible for completing it. This does not mean that there are only tasks for that department to be

done, but the assigned department is responsible for pushing all the other departments to complete the tasks. The colourful logic diagram is used to create a project overview for all departments, seeing how the involvement from every department affect the project, and when the tasks need to completed. When creating this logic diagram, managers from all departments except marketing was involved, but the process itself is very RD driven.

4.2.2 Communication Kalmar

The following sub chapter describes the communication at the Kalmar unit.

Meetings

Meetings are held both on a daily, weekly and monthly basis.

Project meeting

The core project team meet when needed, daily or weekly, to discuss the projects progress. No manager is attending this meeting if not needed.

Pulse meetings

The Pulse meetings are held once a week and consists of the PM and the managers of the involved departments. The meeting is cross departmental and aims to "take the pulse" on the project. This meeting is held in the Pulse room which has all necessary information and project updates on the wall to help visualize the project status. The marketing department however, are usually not attending due to their location in Essen. The PM presents current status for the project and escalates if there are any major problems that need attention and action. The meeting also function to update the risk analysis and all information on the walls in the Pulse room.

Department meetings

These meetings should be held once a week and exist to update the department of current status and problems, but currently only exist in the Production department. The other departments have their meetings when needed.

Monthly project reporting meeting

Once a month every project, not only NPD projects but also other things, such as investments in the factory which will also demand resources, are reported at this meeting.

Escalation meeting process

There is an implemented escalation process starting with the first meeting in the factory. There should then be a department meeting every day at 8.35, but this is only done by Production and not by RD or Purchasing. The other departments have department meetings when it is needed. The production department meeting is held every day in the Pulse room and status/problems from the factory meeting is presented/discussed. If there are any major problems for that day, it is solved in this meeting. Information from the department meetings are then brought to the weekly Pulse meetings.

PDC

The Product Development Council (PDC) meeting is held once a month and function as the Gates in the Stage Gate process. It is managed by the VP for RD and have attendants from all departments and all PCs in the HAT division. The meeting is a

phone conference where Webex is used for participants to call in and for the VP to share screen with the rest. PMs are presenting current status for the projects and if needed request for phase transitions, approval for ordering material or extra resources, delays or declare problems that needs to be solved.

Cross departmental communication

There are some cross departmental meetings as previously described but the most common communication is done face-to-face. Because it is a small PC, the employees go and find the person they need to give/receive information, or send an email. Except for the weekly Pulse meeting, there is the PDC meeting held once a month. This meeting is attended by people from the entire division and the main goal is to discuss status of running projects. Furthermore, Kalmar uses Sharepoint to upload and share documents with the other departments.

Inner divisional communication

The communication between Essen and Kalmar is very poor and mostly done by email. There is a strong sense of "we" and "them", with very high competitiveness. The marketing department is the same for both Essen and Kalmar and located in Essen. Therefore, it has been very little communication between this department and the rest in Kalmar. However, there is a plan to have the newly hired Product Portfolio Manager to come and visit Kalmar once a month.

Inner divisional collaboration

Due to the politics and competitive environment between Essen and Kalmar, together with two different NPD processes, there is no existing collaboration nor knowledge share between the two PCs. None of the PCs can access documents from the other but have to email and ask for that specific document if needed.

4.2.3 Management Tools Kalmar

Kalmar is using a wide range of interfaces and software to monitor the projects, see *Table 15.*

Table 15 - Management tools and software used by Project Managers at PC Kalmar

Excel	Used by most PMs to create project time plan and budget.
Lotus notes	Old storage/data base still used to a certain extent. Will be replaced by Share-point in the future.
MS Project	A few PMs use this software to create the time plan.
Gibraltar	Project overview tool to get an overall perspective of all running projects. Mainly used by VP DD.
Windshield / PDM-Link	Used by Design engineers to release their drawings.
Office 365	Used by all employees for email, calendar, booking meetings etc.
Webex	Used by all for Virtual meetings, ex PDC.
Sharepoint	Future storage/database, used to a small extent.
SAP	The ERP system, managed by Semir Dzogovizc, production, for project related tasks. All employees type in their own man hours.

It is not demanded that the PMs uses certain interfaces/software when creating the time plan /budget or following up deliverables during the project. At the moment, the logical diagram together with the excel file is most commonly used. Each PM can decide how and what tools to use when managing the project.

Risk analysis structure

The aspect of risk analysis is included as deliverables in the logic diagram at least once in every phase. The risk analysis is further implemented at the daily Pulse meetings held in the production, as described in the previous communication section.

There is a template to follow when finding a risk. This template includes how to rate the risk by using a Probability/Consequence diagram, see *Figure 40*. Furthermore, it contains description of the risk, assigning it a number, the probability, consequence, prevention to minimize the risk, the expected result of the prevention, person in charge, finalization date and progress updates.

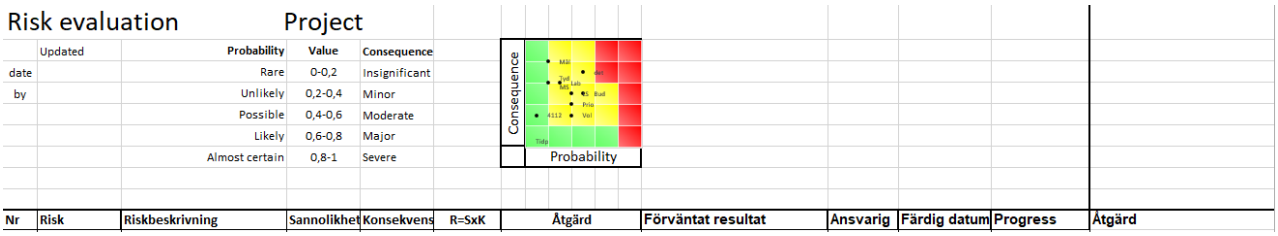

Figure 40. Kalmar Risk analysis

4.2.4 Resource Allocation Process Kalmar

This subchapter explain the resources allocation process at the Kalmar unit.

Project resource allocation

Once a project idea has been approved, the PM is appointed by the Manager for RD. The PM is a design engineer and will function as both PM and design engineer for the upcoming project in the first three phases. The PM creates a proposed time plan and depending on needed resources to achieve the time plan a budget is created. The proposed budget is an excel file stating the needed man hours and all expected costs for the project. The actual costs for the projects are reported once an order is placed and taken out of the budget. SAP contains the actual costs where each project has different categories, ex standard cost structures, man hours etc. The finance department provide a printed excel list from SAP every month with the project costs which are then compared to the budget in the excel list. The budget is updated/modified at project meetings before entering the gates, depending on delays or change of launch date etc. Cost allocation is independent from the project time plan software.

The proposed time plan and budget is then presented to and reviewed by several line manager to evaluate and if needed improve the estimations. The people to join the project team are updated and then approved by the managers and the VP for RD. Depending on the size of the project, a team of design engineers, production engineers and test engineers is formed, supported by the Marketing department and Purchasing department. Resources for the Project is further requested at the PDC meeting. It is a feeling that these request often are being cut and that the final resource proposal seem impossible. The project budget and project plan is also approved at PDC, meaning that all costs for the project has been approved when the project is started. There are no criteria or priority level for the various projects deciding which project/projects will get the recourses if the limited resources are not enough for all running projects. All managers meet once a month to discuss obstacles, updates and can escalate these if there is a need for prioritization due to lack of recourses. It is described that there is a main focus on needed time and secondary how many resources it takes to achieve it.

After the first three phases a new PM for the final two phases is appointed. This new PM is a production engineer and will be in charge until market launch is done. There is a handover meeting held by the previous PM from RD and the new PM from Production, with a contract/checklist. The new PM can decline taking over the project if not all previously deliverables are fulfilled.

Resource exchange between Kalmar and Essen

There is no resource exchange or knowledge share between Kalmar and Essen as described in previous subchapter. In this section resource exchange is represented by any exchange of knowledge or human resources between projects conducted by both product companies for new product development.

5 EMPIRICAL ANALYSIS

The following chapter regards the empirical analysis which involves a statistical analysis of the qualitative data acquired through interviews. This section stands to quantify the qualitative data in order to numerically identify the key problem areas of current NPD processes used in both product companies. This identification supported by statistics therefore justifies the need for standardisation of new product development process on a divisional level and also permits the outlining of strength´, weaknesses and optimization areas from both parties involved in this project e.g.: The Epiroc unit in Kalmar and in Essen.

5.1 Statistical Analysis

The hereby statistical analysis is produced to support the identification of principal problems/ issues on which solution development will be focused. The satistics drawn for this analysis where derived from qualitative data acquired through a series of 21 semi-structured interviews covering all departments involved in the new product development porcess both at the product company in Kalmar and Essen.

First categorization of stated problems

The first categorization of stated problems consists of placing all issues derived from the interviews into problematic categories. These categories contain all problems related to a common issue with regards to the NPD processes in Kalmar and Essen and are shown below:

Table 16 - First Categorization of stated problems

First categorization	
Color Code	**Problematic category**
	Marketing commitment
	Deliverables
	Phase in/ Phase out
	Purchasing performance
	Department responsibilities
	Communication Kalmar & Essen
	Risk analysis/Lessons learned
	Communication Cross-Department
	Implementation of NPD
	Project overview
	Feasibility issues
	PDC issues
	PM role
	Delays in testing
	Communication in department

** Take note that the *PDC issues, PM role* and *Delays in testing* are categories only present for PC Kalmar

Selection Criteria

The classification of all problems derived from interview was done according to two principal criterions which are described bellow by variables *a* and *b*.

a classification variable

$$a = Negative\ impact\ on\ project\ timeline\ (delays)$$

$$a = [1 - 2 - 3 - 4 - 5]$$

Each stated problems has been appointed a grade 1 to 5 based on their impact on the complete project timeline (i.e. the delays created by the stated problem). The variable *a* attributed to each stated problem is presented in *Table 17* and *Table 18* in the *APPENDIX B.*

b classification variable

$$b = Number\ of\ departments\ affected\ by\ the\ problem$$

$$b = [(1\ to\ 2)\ dept. - (3+) dept.]$$

The number of affected departments is determined by the first categorization. For example, if issues associated to the "*Marketing Commitment*" category are mentioned by 3 or more departments, the value of *b* is 3+.

Classification Matrix based on a and b variables

Based on the *a* and *b* value associated to each problem, a matrix was built for PC Essen and for PC Kalmar showing the amount of stated problems derived from interviews for each variable, see *Figure 41* below.

ESSEN		NEGATIVE IMPACT ON PROJECT TIMELINE	
		UNDESIRABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO PROJECT TIMELINE (0-2)	INTOLERABLE SERIOUS IMPACT ON PROJECT TIMELINE (3-5)
AMOUNT OF DEPARTMENTS AFFECTED BY PROBLEM	3+ DEPT. AFFECTED	3 5 6 7 8 9 10 11 13 14 20 21 31 33 53 58 68 71 83	2 4 12 15 18 19 22 23 24 25 26 27 28 29 30 32 44 45 46 47 48 49 50 51 52 54 55 56 57 59 60 61 62 63 64 65 67 69 70 72 73 74 75 76 77 78 79 80 81 82 85 86 87 88 90 91 92
	1-2 DEPT. AFFECTED	39 42	1 16 17 37 38 40 41 43 84 89

Figure 41 - Classification Matrix for PC Essen

KALMAR		NEGATIVE IMPACT ON PROJECT TIMELINE	
		UNDESIRABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO PROJECT TIMELINE (0-2)	INTOLERABLE SERIOUS IMPACT ON PROJECT TIMELINE (3-5)
AMOUNT OF DEPARTMENTS AFFECTED BY PROBLEM	3+ DEPT. AFFECTED	11 12 13 14 18 20 21 24 25 27 74 75 76 77 78 97 98 100 101	1 2 3 4 5 9 10 15 16 17 19 22 23 26 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 50 51 52 53 54 55 56 57 58 59 61 71 72 73 79 80 81 82 83 84 85 88 89 90 91 92 93 94 95 96 99 102 103 104 105
	1-2 DEPT. AFFECTED	7	6 8 46 47 48 49 86 87

Figure 42 - Classification Matrix for PC Kalmar

The numbers presented in *Figure 41* and *Figure 42* represent Number IDs associated to each stated problem derived from interviews both for PC Essen (1 to 92 in the Essen matrix) and PC Kalmar (1 to 105 in the Kalmar matrix) (See *APPENDIX B*). As shown in these matrixes, most of the stated problems affect more than 3 departments and are subject to generate negative impact on project timelines. For this statistical analysis, the problems affecting more than 3 departments were considered (blue cells in both matrixes). Problems mentioned by the General Managers were more of overall problems and therefore not precisely oriented on the NPD processes. They are not considered in this analysis. Furthermore, problems 66 for PC Essen and 60-62 for PC Kalmar were judged irrelevant to this study and were discarded.

Statistical analysis Product Company Essen

Following the establishment of variable *a* and *b* and following the matrix classification shown above, *Figure 43 - 47* below display the quantification of the stated problems with regards to the *First Classification* categories PC Essen.

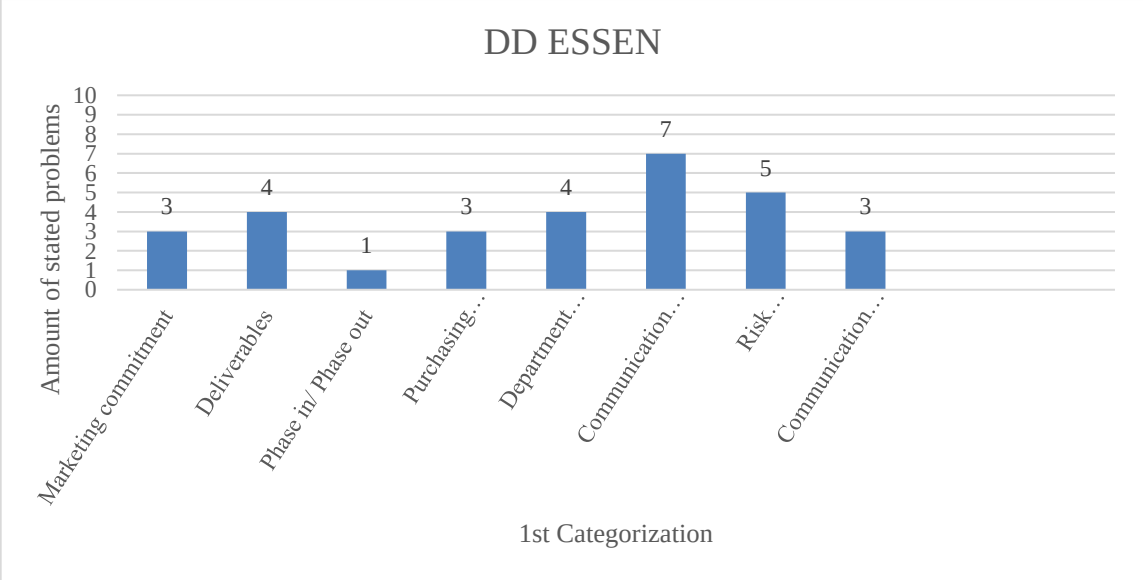

Figure 43- Statistical Analysis DD Essen

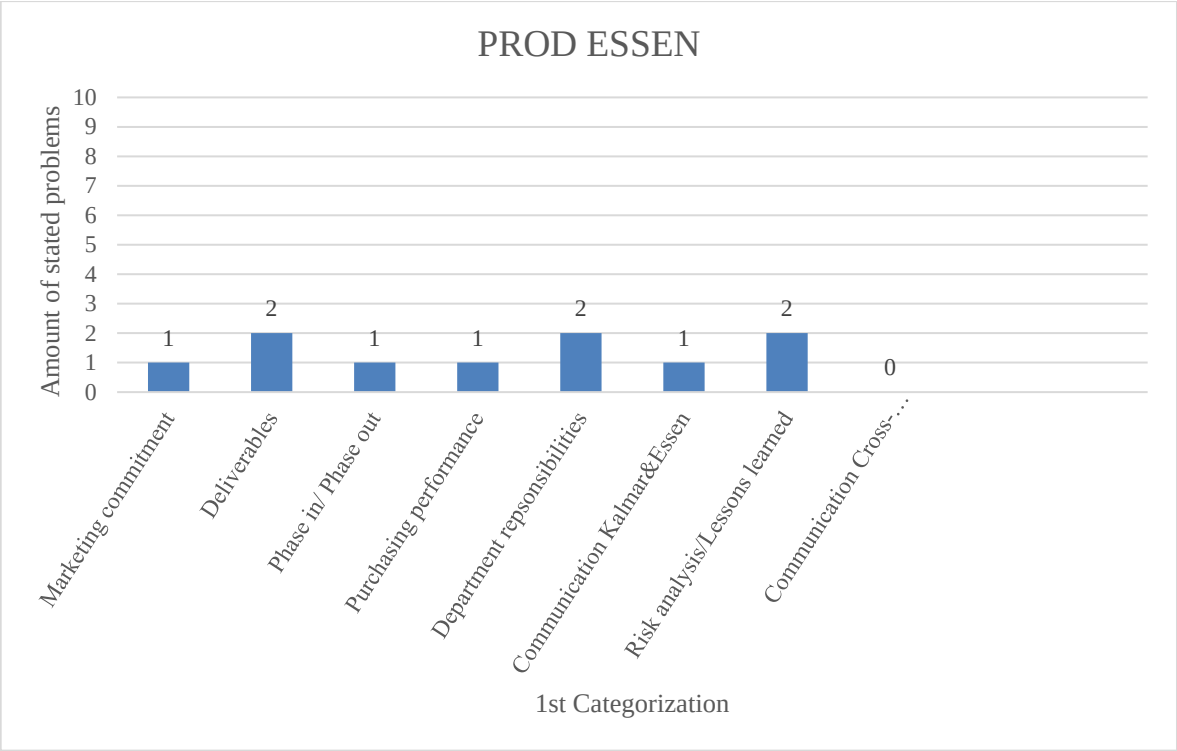

Figure 44 - Statistical Analysis Production Essen

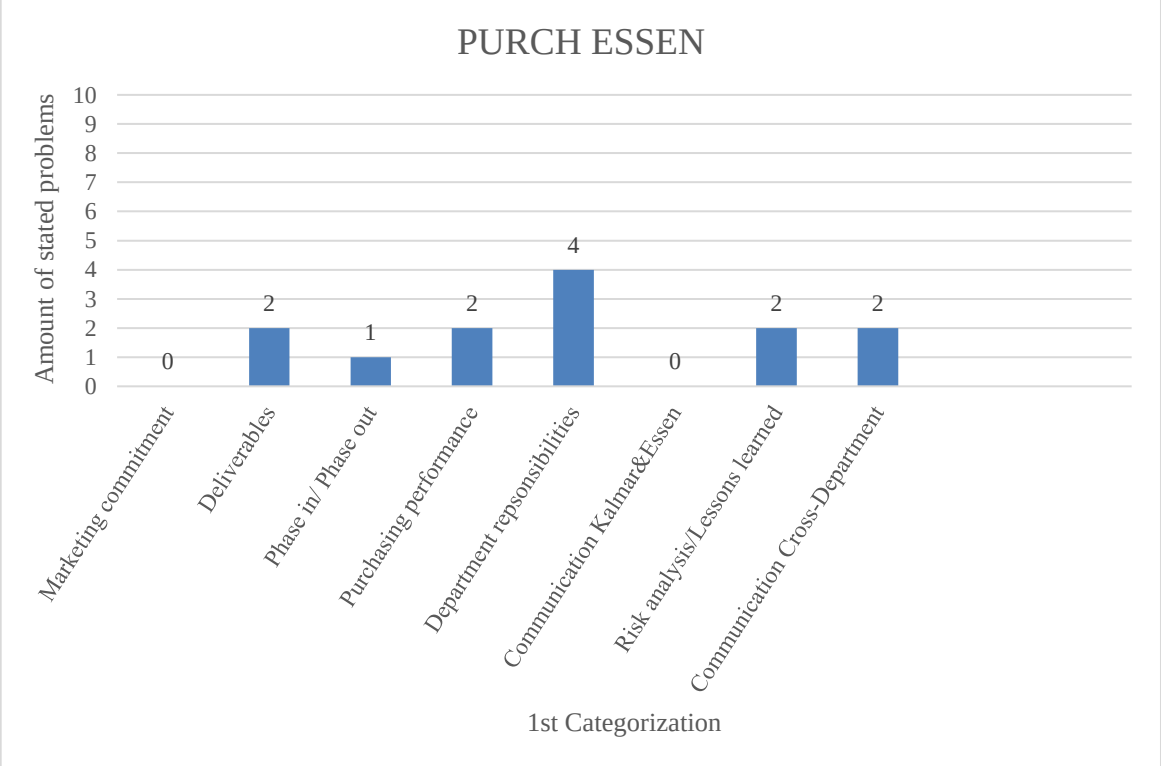

Figure 45 - Statistical Analysis Purchasing Essen

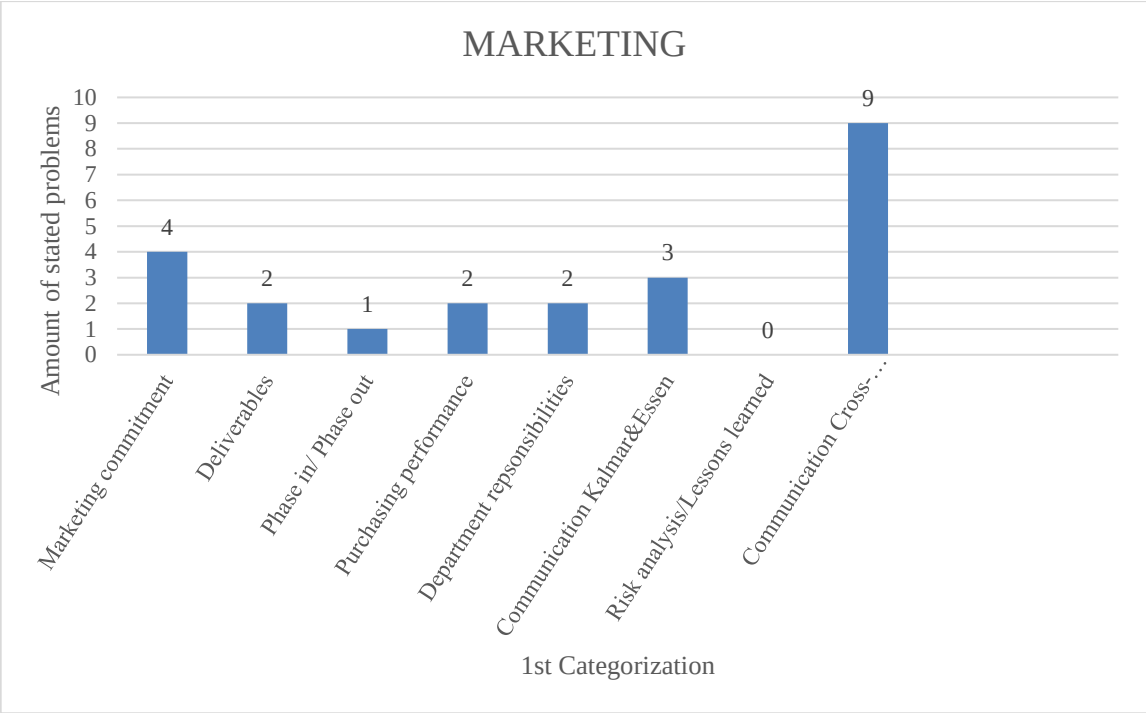

Figure 46 - Statistical Analysis Marketing (Essen - Kalmar)

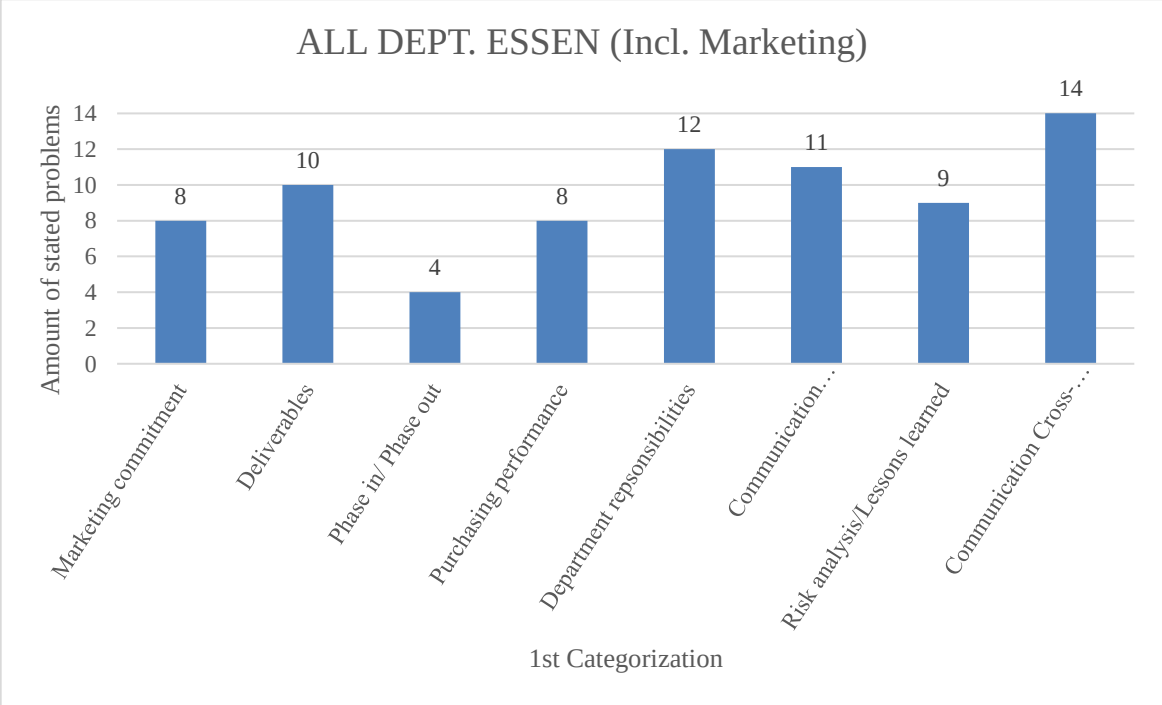

Figure 47 - Statistical Analysis all Dept. Essen (Incl. Marketing)

Figure 47 shows the statistical values for the combination of all departments in Essen. It is observable that *Communication Cross-Department* and *Department Responsibility* represent the two categories with the most mentioned problems with higher impact on project timelines. It is also important to consider that these numbers include the marketing department which is the same for both PC Essen and PC Kalmar. Once again, these values are derived from the mentioned problems in the interviews conducted in Essen.

Statistical analysis Product Company Kalmar

Following the establishment of variable *a* and *b* and following the matrix classification shown above, *Figure 40 - 51* display the quantification of the stated problems with regard to the *First Classification* categories for PC Kalmar.

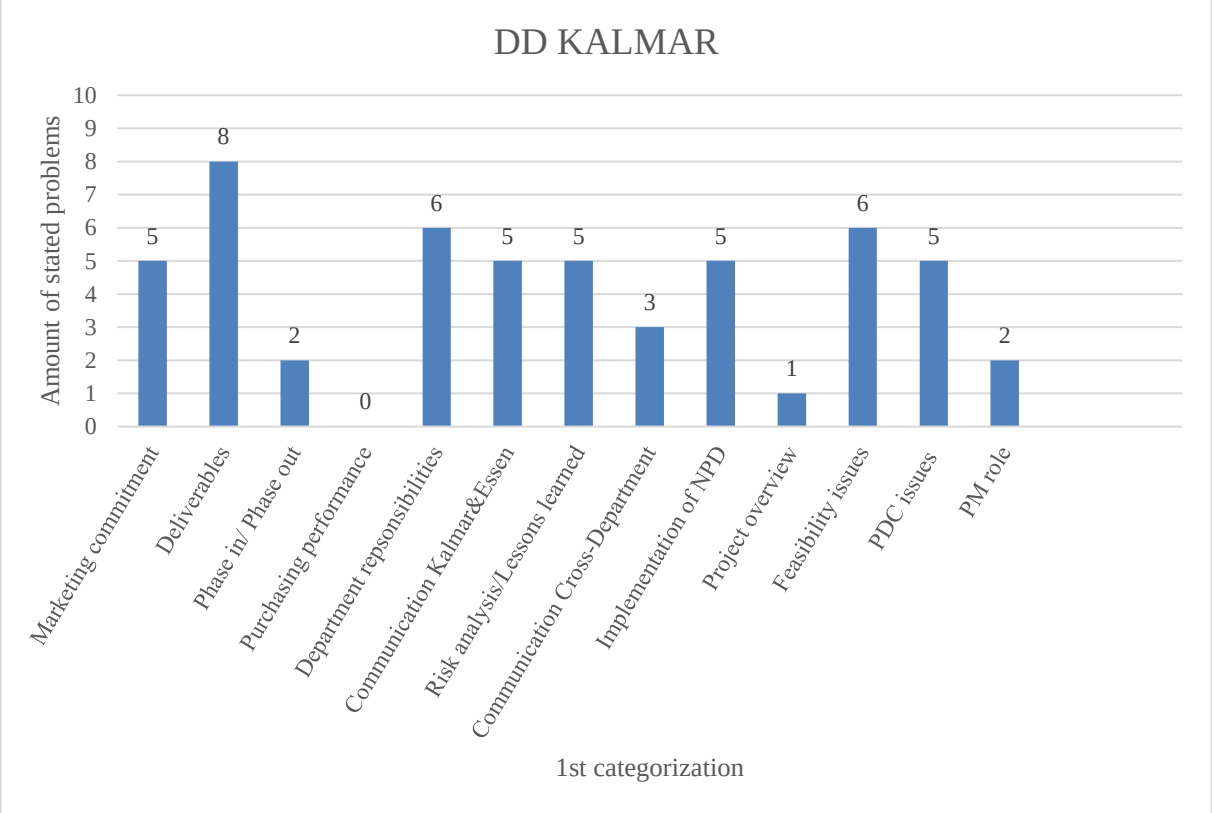

Figure 48 - Statistical Analysis DD PC Kalmar

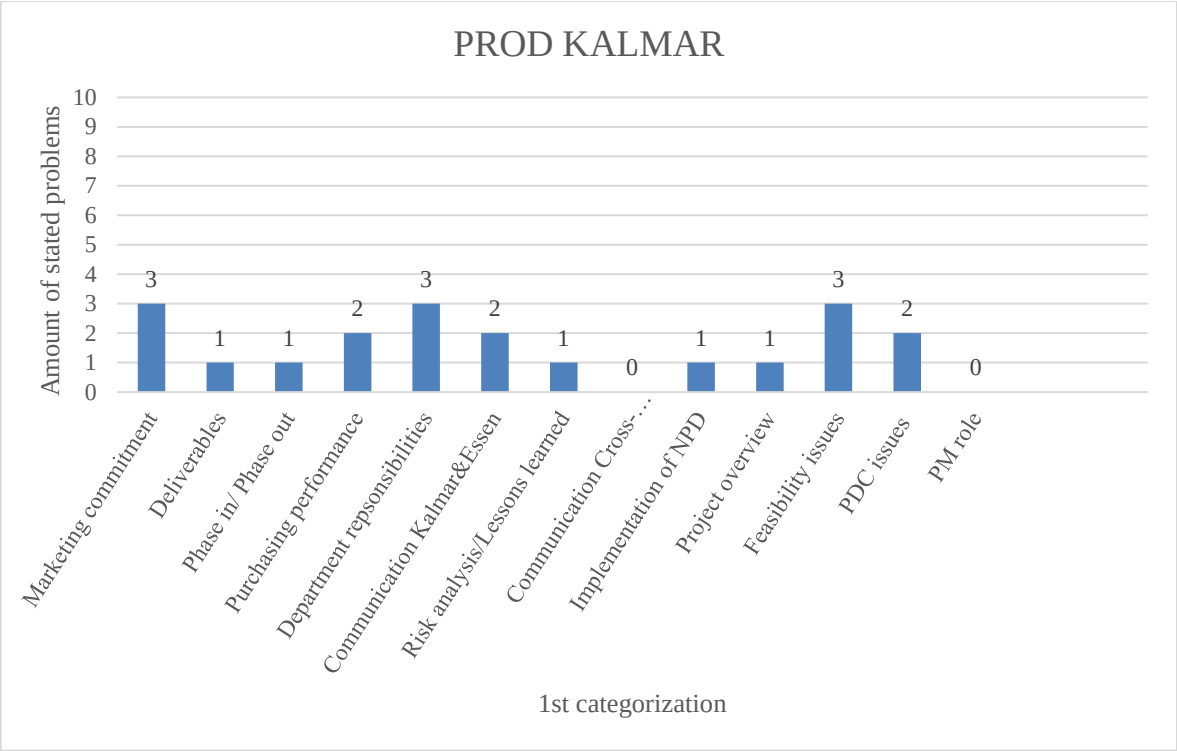

Figure 49 - Statistical Analysis Production PC Kalmar

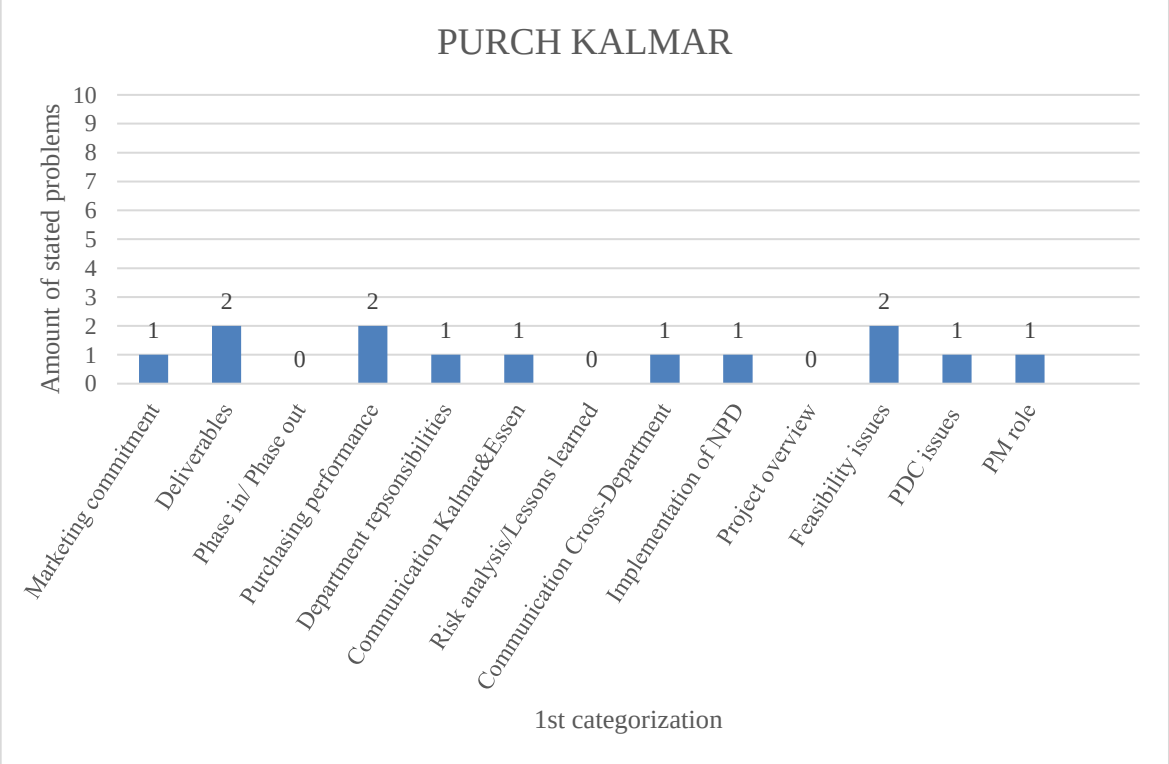

Figure 50 - Statistical Analysis Purchasing PC Kalmar

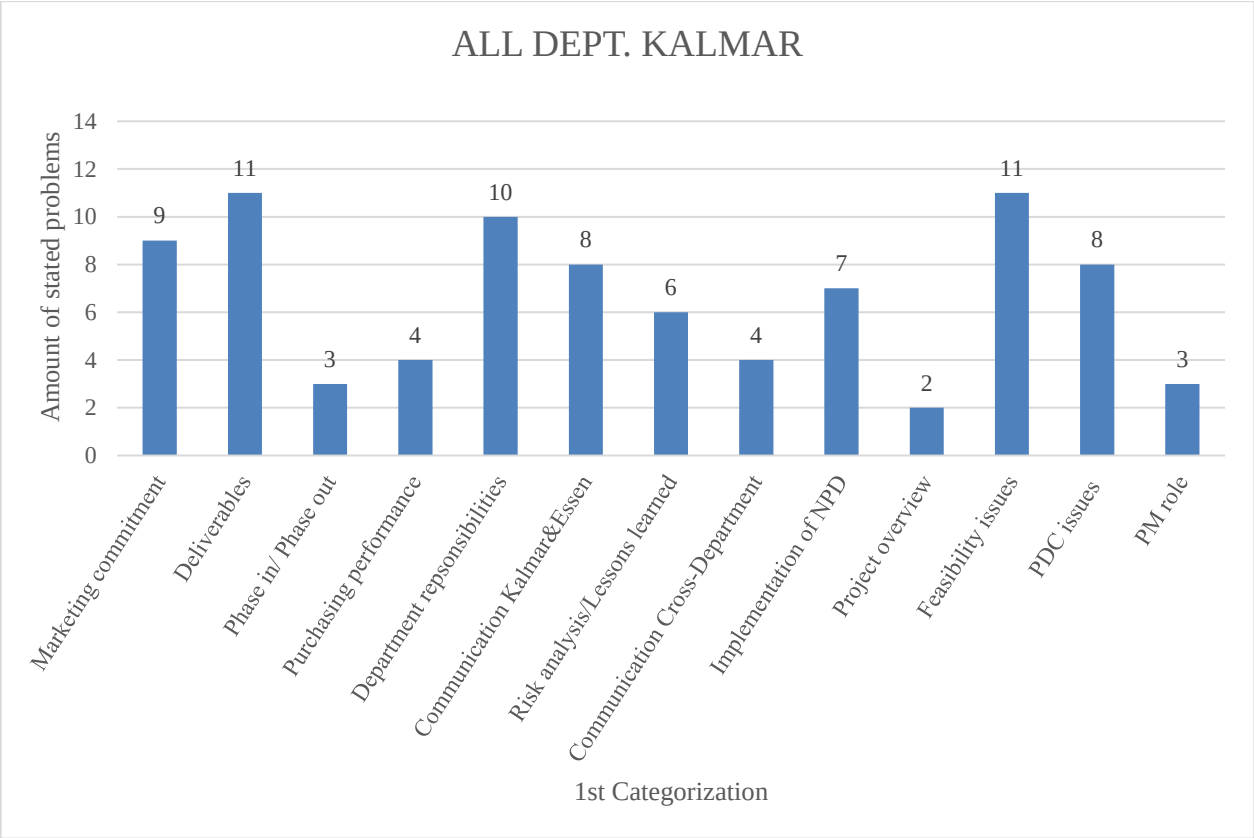

Figure 51 - Statistical Analysis All Dept. PC Kalmar

From *Figure 51* above it is observable that, for PC Kalmar, *Feasibility issues* and *Deliverables* represent the two most mentioned and most impactful problem categories derived from the interviews conducted in Kalmar. Following closely is *Departmental Responsibility* category which shows some similarities between the analysis done for PC Essen's and PC Kalmar's mentioned problems.

Overall results of Statistical Analysis

When combining all stated problems from both product companies, the categories to which most of the interview stated problems are associated were established.

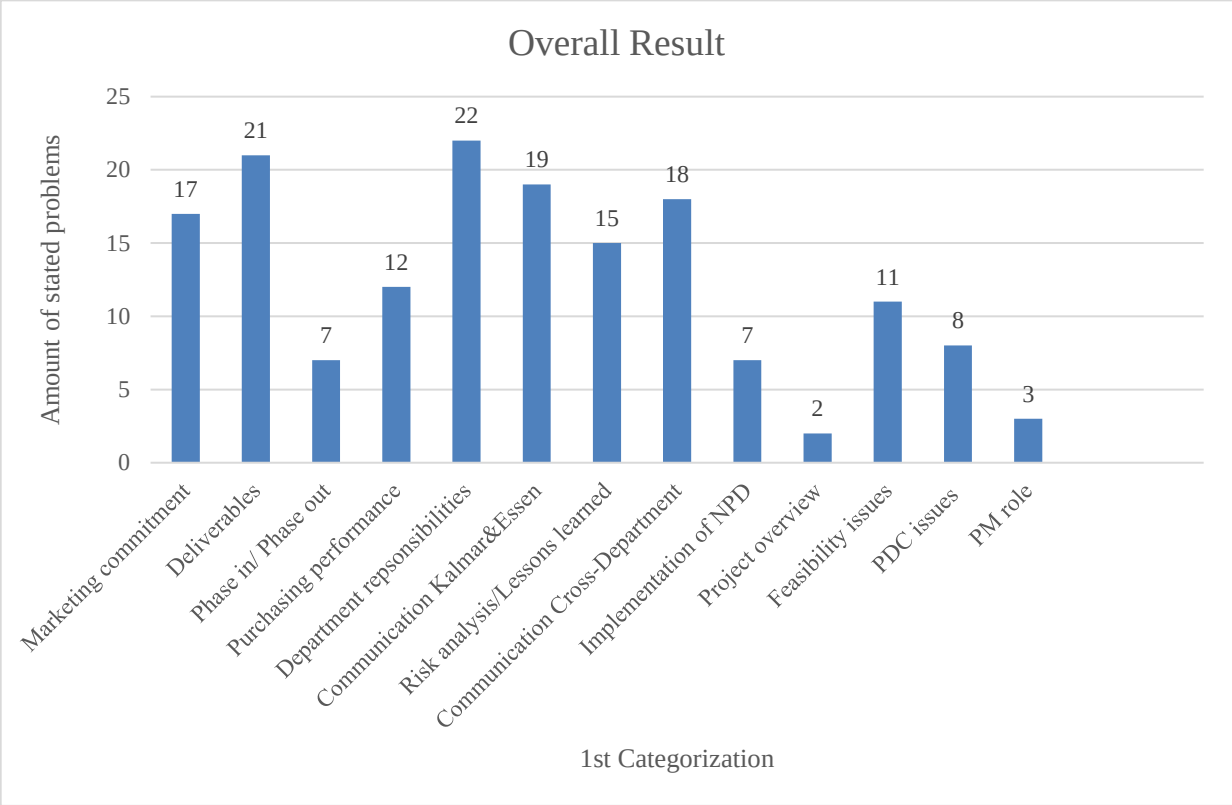

Figure 52 - Overall Result for all Dept. from PC Kalmar and PC Essen

As shown on the above graph, *Department responsibilities* and *Deliverables* represent the two problems category generating most delays and affecting most departments according to the 21 interviews conducted. This indicates that the results wanted for this thesis should aim at helping reduce the issues generated by the responsibility ambiguities encountered by all departments when going through the NPD processes for the development of new products. The Deliverables of both NPD processes (Essen and Kalmar) shall also be worked on in order to optimize new product development projects. With this in mind, the establishment of a common first level of deliverables for both PC Essen and PC Kalmar will help reduce the deliverables ambiguity and will define clear departmental responsibilities for each deliverable as well as helping with the communication cross-department. Furthermore, this deliverable proposal being common between PC Essen and PC Kalmar will increase the understanding and communication between both PCs. By creating this common thread of deliverables for each phases of the stage gate process, mentioned issues such as *Marketing Commitment* will also be affected positively.

5.2 Identification of Optimization Areas at Essen PC

Following the statistical analysis and the interviews conducted at the product company in Essen, weaknesses and strength of the current new product development process were identified. From these strengths and weaknesses were drawn the optimizable areas of said NPD process and presented below.

Identification of weakness

One of the most stated issue with the current NPD process at the product company in Essen by all departments studied is with communication across departments. Indeed, as supported by the statistical analysis above, communication cross-departmental comes in at the highest stated problem. Interviewees relate that the current product development process sees misunderstandings, ambiguities and delays due to lack of correct reporting and communication between said departments. Furthermore, departments involved in the NPD process tend to keep the information for themselves and not necessarily communicate it directly with other departments as they do not see the urgency to do so. This behaviour leads to project managers always having to "fish" for information resulting in waste of time.

Another key problem are regarding the current new product development process at the Epiroc unit in Essen stands in the departmental responsibility. Once again statistically established as a principal weakness, the responsibility and involvement of each department in new product development project is not clear for all departments. Indeed, as the current process is driven by the *Design and Development* department to which the project managers belong the deliverables from the project planning are created and tailored to the D&D department but no deliverables are specifically generated for other departments. This results in some departments having no distinct understanding of the D&D deliverables and to which phase they belong or which phase the projects are. The project overview is thus restricted for other departments which burdens their capability to participate more accurately in new product development project. Furthermore, it was also mentioned that the deliverables used for NPDs are not communicated optimally and not from top management which makes it difficult for departments other than D&D to get a feeling of ownership or valuation through these deliverables.

Still with regards to the issue of department responsibility, the involvement of the marketing department in new product development project was mentioned unanimously through all project managers. Indeed, the input from the marketing team is crucial all though a project but more specifically during the feasibility study phase where their input from the market is what generates new product development projects and there has been a noticeable lack of involvement on the marketing side with regards to their participation in the production of the master specification document which represents the initial document of any projects involving new products.

Finally, another majorly mentioned issue in the current NPD process at the product company in Essen stands in the capacity of the purchasing department. Although nothing can be done as part of this research to address this issue, the purchasing department is currently overloaded with works and request and cannot perform accurately do to a lack of resource. Indeed, due to the higher amount of orders from the market and due to the incoming new product lines, the purchasing department cannot

keep up with the work flow and current suppliers do not have the capacity to produce efficiently either. This represent a major issue as it generates major delays in projects.

Identification of strengths

The current NPD process at the product company in Essen is highly thorough in its time planning. Indeed, the use of the MS Project software is highly developed and all new product development project use a similar frame including their deliverables in this software to monitor progress, time and cost. All delays or modification of said timeline or cost are recorded in the management tool which allows the project manager to reach great control on their projects. The MS Project software also interacts directly with the ERP system in place at the product company in Essen which thus sinks perfectly the time planning with the cost allocation. The way time is managed in new product projects in The Essen unit represents their most substantial strength.

Furthermore, the implementation of any new method or process is highly effective in the Epiroc unit in Essen. Indeed, if new interfaces, processes, methods or approaches are given by higher management, they are implemented right away and accurately. This represents a strength of the product company in Essen especially for a standardization of the NPD process if ever agreed upon by both product company.

In addition to the above mentioned strengths is the escalation meetings held every day by top management. These meetings consist of escalating current issues from all lower level of departmental structure all the way to top management which then work on solutions prior to sending their elucidation down to all structural level of each departments from which the issue arose.

Identification of possible standardization processes

Both new product development processes are standardizable given that both product companies make an effort to adapt their current processes. On a more technical aspect, deliverables, phases and their transition and the stage gate process in general are standardizable areas of the process as both product companies are aiming at a the usage of a stage gate process. Furthermore, purchasing processes and strategies could potentially be an interesting area to standardize which would allow collaboration between the two product companies and help lower the work load on the understaffed purchasing department in Essen.

5.3 Identification of Optimization Areas at PC Kalmar

Due to the fact that no big NPD project has been through the entire “new” NPD process with the logical diagram and deliverables, it is difficult to analyze the effects of this new process and how it will actually be performed. The current split from Atlas Copco, taking away several products from PC Kalmar, and the recently done re-structuring of the PC Kalmar (2017) are some of the reasons why there are no running NPD projects in Kalmar at the moment. This is a big disadvantage when analyzing the process in Kalmar.

Identification of weaknesses

A major issue for Kalmar is that most projects have been/are exceeding the budget and/or are delayed. The main reason is described by several interviewees as problem in the feasibility study. The biggest issues in feasibility is expressed to be with regards to knowledge and time estimation. Several interviews explained that the time plan is often

underestimated, not realistically estimated and hence the resource allocation is done "eye balling" rather than realistic estimation. It was also stressed that there are a lot of gaps in the feasibility, and that projects are then started without solving them first.

The reason may be tracked to the lack of a strong, consistent planning process together with the resource cuts. There is a risk with not having a strong planning processes, making it difficult to support why resources should be approved and to predict the future as correct as possible. The deviation in the planning process between the PMs, having some PMs using excel, others MS Project, also hinders the knowledge share within the department and the development of best practice. The lack of a strong planning process further complicates the estimation for the Project Cost.

There is also a trouble with looping in the Stage gate process, which again can be tracked to planning issues. Looping between the design phase and prototype and testing is currently the biggest issue, and not taken into consideration when planning the project. Again, this is tracked to gaps in feasibility study due to insufficient planning where iterations for design and prototype/testing is not accounted for in the time plan.

The deliverables for the NPD proves has been rated as one of the biggest issues at PC Kalmar according to the interviews and statistical report, where it was an upcoming statement throughout the interviews that there are too many deliverables and too heavy administration.

The statistic report from the interviews in Kalmar further highlighted problem with "department responsibility". The criticism was mainly with regards to the process being very RD driven, due to the fact that the PM is also a design engineer in the project, and that it might lose focus on other important aspects. It was further stressed that the transition of PM, and that department commitment from other departments was lost by having a PM which was also working as a design engineer or production engineer.

Another department responsibility issue is the collaboration with marketing. All departments in Kalmar expressed the lack of marketing commitment in the projects. The lack of marketing input in the feasibility study, again, prevents the possibility to estimate a good and realistic time plan and budget for upcoming projects. Due to the fact that a lot of the communication in Kalmar is done by going to the office of the needed person, having a face to face conversation, and marketing is located in Essen, a lot of information is missed/not communicated which further complicates the collaboration.

Identification of strengths

One of the main strengths at the Kalmar PC is the visualisation of the project created by the logic diagram. Having all departments involved in the creation of the processes, and dividing the responsibilities visualised by the colours, has created an easy tool to get an overview of the project process, to understand the relation between the deliverables and how the departments depend on the other departments deliverable. This is further strengthened the involvement from the other departments in the NPD process.

Another strength at PC Kalmar are the Pulse meetings held to continuously checking up on the projects. This cross departmental meeting strengthens the collaboration

between the departments and the communication. It further minimizes risks which are occurring throughout the project life cycle. Having the meeting in the Pulse room with all important information visualised on the walls, again show the Kalmar strength in visualisation and creates a good foundation for cooperation.

Identification of possible standardization processes

The standardization of the process for Kalmar and Essen is considered to be possible, after the biggest obstacles have been solved. To do so there is a need for set of standardized deliverables which are the same for both PCs. Furthermore, the logical diagram needs to be updated with accordance to the new set of deliverables, taking the process for both Kalmar and Essen into consideration. There is also a need to standardize the creation of the time plan, one way to do so would be by applying the deliverables to MS project. The Stage Gate approach is another aspect that needs to be discussed and agreed upon together with the main deviations found in the processes between the two PCs.

6 ANALYSIS AND DISCUSSION

The findings generated from the qualitative research done for this thesis lead to the analysis and conclusion of the status of standardization of the new product development process on a divisional level for the *HAT* division of Epiroc. The following section explains the analysis of said findings and the justification of the obtained results.

6.1 Current Stage Gate Process

Cooper (2007) rate the gates to be to be most common problem and the weakest point for most companies using the Stage Gate model which is also the case for both PC Essen and PC Kalmar due to the lack of rigorous gates through the entire process. The PDC meetings indeed function as gates with gate keepers, but lack the criteria to truly evaluate the decision to keep investing in the project or not. The meetings are held with the best intentions at both PC Essen and PC Kalmar but, as described by Cooper (2007), are rather a project update or review meeting. Instead of being a clear project kill/go/pause meeting, it is a milestone checkpoint which evaluates if the project is on time and within budget, but lacks the discussion about further investments to the project due to other circumstances. The process should be a funnel, not a tunnel as described by Cooper (2007), where all gates need to be go/kill/pause decision points, not just the first one generating a "five stage, one gate-process". The exiting process at PC Kalmar and PC Essen where the entire project budget and time plan are approved in the beginning of the project further support this finding, and correspond to the phenomenon expressed by Cooper (2007) to have "Gates with no teeth". Cooper (2007) explains that it means that if a project has been approved it never gets killed, which strongly resembles the current NPD process for PC Kalmar and PC Essen. Rigorous gates require not only deliverables but criteria and output (Grönlund et al., 2010). The current model at PC Essen and PC Kalmar is thus not a fully completed management process and can therefore be, as described by Stošić & Milutinović, (2014), an issue for innovation which is a key element for NPD.

There are no existing criteria to prioritize the running projects, hence a lack of teeth. The main issue for PC Essen at this moment are the resources which are not enough for all running projects. It is problematic to lack criteria to decide which projects that should keep going and be invested in at this moment and which once that need to be paused or even killed. PC Kalmar does not share this issue at the moment due to an absence of NPD projects and there is therefore no need to prioritize. Grönlund et al (2010) suggest that the criteria should be organized into scorecard which can include focus points like strategic fit and/or expected profit. Grönlund et al (2010) further suggest to use these criteria in the important rigorous decision making process, the output, where the gate keepers should not be afraid to pause/kill a project even though they have already invested in it. The output should also contain an execution plan containing dates and deliverables. Developing stronger criteria would strengthen the NPD process greatly for both PC Essen and PC Kalmar by adding a priority function for the projects. This would further support the decisions to where recourses should be prioritized.

6.2 Deviations and Disagreements

The adaptation both Product Companies have made of the stage gate process theory to build their respective new product development processes is mainly based on the foundations of each organizational operating structure. Indeed, the decision to adapt the theoretical concept of stage gate process is triggered by the functioning infrastructure in place in both product companies with regards principally to resource allocation and organizational structure which collides with a traditional organizational structure proposed by Kerzner (2013). Therefore, the differences in operating structure and organizational structure between the two divisional offices generated deviations in new product development processes that prohibited the standardization of such process on a divisional level. Furthermore, these deviation in structural foundation led to several disagreements on other concepts and understandings which also hindered the standardization of the NPD process in the current situation.

6.2.1 Deviations

From the deviations constraining the standardization of new product development process on a divisional level, the resource allocation structure represents the principal obstacle. Indeed, the differences in cost allocation for projects and the usage of enterprise resource planning (ERP) systems generates disparate approaches to projects. When looking into cost allocation, it is observable that the Product company in Kalmar allocates cost in the project phase in which the cost occurs regardless of the final deliverable for which the cost is necessary. For instance, cost allocation for the purchase of raw materials needed in the production preparation phase might occur in a previous phase due to long lead times and will thus be allocated at the time of the purchase. Oppositely, the product company in Essen possesses a cost allocation structure for which cost are allocated in the project phase in which the deliverable generating the cost is located. Cost allocation structure in Essen is therefore related to phases and deliverables whereas cost allocation structure in Kalmar works according to occurrence time. Furthermore, the use of ERP system (SAP) with regards to cost allocation is also built differently between the two units of Epiroc. Indeed, the product company in Kalmar uses the ERP system as a monitoring tool to compare budgeted costs (using Excel) with actual costs (SAP reports from finance department) whereas the product company directly inputs costs in the ERP system which is linked and interacts with their project time plan software (MS Project). This major deviation in functional structure opposes the project triple constraint model proposed by Tayntor (2010) and Kerzner (2013) stipulating that all three constraints (time, resources and scope) affect each other and must be balanced in order to reach success in projects in the sense that balancing is not possible if two parties of an organization (in this case Essen and Kalmar) have a different structure for one of the constraints (cost resource). Indeed, differences in cost allocation hinders the balancing of the three project constraint on a divisional level therefore obligating both Product companies to work independently thus impeding the standardization of the new product development process between the two.

Moreover, the organizational structure of both product companies is different in its project structure. Indeed, the product company in Kalmar performs a shift of Project manager before entering the production preparation phase of the process. This shift in project manager translates into a transfer of responsibility from the design and

development department to the production department just before entering production. On the other hand, the Essen unit of Epiroc conserves the same project managers throughout all phases with no significant shift or responsibility between departments. By working with different project structure, the standardization of one process for the division becomes complicated as both parties responsibilize their project managers differently.

6.2.2 Disagreements

Given the above mentioned deviations in functional structure, disagreements arose when trying to standardize the new product development process. Indeed, several of these disagreements are caused by the differences in the foundation upon which project are built and executed in each product companies. Any movement of deliverables from one phase to another to generate a standardized process had an impact on either product companies due to the resource structure and project structure (cost allocation and project manager responsibility for instance).

The flexibility with regards to theory behind concepts and approaches used in both product companies also represents a main source of disagreement when trying to design a common product development process. Indeed, with regards to the concept of stage gate process, both product companies currently use an adaptation of the theorical stage gate process tailored to their specific situation. Although being an adapted version of the theory, the Epiroc unit in Kalmar showed more flexibility in their respect of theory and referred to their process as a stage gate process whereas the Essen unit did not agree with associating current NPD processes to a stage gate process as they represent an adaptation of the theory. This flexibility disagreement lead to similar issues especially regarding the concept of deliverables. Indeed, for the product company in Kalmar, deliverables represent all tasks to be completed in order to move on to the next phase which differs from Essen's perspective on deliverables which defines them as critical/key milestones to be completed prior to phase transitions. This divergence in flexibility from theory describes why the product company in Essen considers the Kalmar process to have too many deliverables or to appoint the status of deliverables to tasks that are not, according to Essen's perspective, actual deliverables (preparation for internal prototype components completed). The difference in flexibility from theory therefore creates different understanding of concepts.

This deviations in understanding of process with regards to deliverables is also observable in the stage gate approach used by both product companies. Kalmar uses the frontloading approach which translate into involving resources and completing tasks as early as possible in a project which is justified by the presence of deliverable for "preliminary verification, verification and final verification" in the current Kalmar process. The product company in Essen involves resources and completes task as soon as possible by overlapping the phases of their adapted stage gate process. This approach in process represents a disagreement hindering the standardization of the NPD process on a divisional level in the sense that, in Kalmar's perspective, only activities leading to the completion of deliverables can be overlapped but not phases or deliverables whereas Essen allows overlapping of deliverables to frontload and respect their cost allocation structure.

Having a different perception of what tasks qualifies as a deliverable and different perspective on overlapping lead to another disagreement obstructing the standardization of the NPD process e.g: the position of phase transition. Ultimately, the phase transitions should happen after completing all deliverables present in the phase (Grönlund et al., 2010). Diverging from the literature, both product companies prone different perspective on phase transition location where Kalmar sees it best happening after all phase deliverables are completed as opposed to Essen's view on having the phase transition prior to major investments decision (ordering raw materials for instance). Once again, this disagreement based on core understanding and respect of theory makes the standardization of both product development processes impractical in the current situation. It is however observable that both product companies agree upon the concept of having the possibility to conditionally transit to the next phase without having completed all deliverables granted the justification of non-completion of these conditional deliverables.

6.3 Next Generation Stage Gate

The current Stage Gate process at PC Kalmar and PC Essen seem to be a combination in between old theory of Stage gate models and an adapted version to fit the NPD process where the deviations and disagreements between the two PCs indicates different understandings of the process. The stage gate model should be a guide of best practises for projects to work an idea to launch, as described by Cooper (2007) and therefore needs to be more than just a flow chart. Both PC Kalmar and PC Essen have several of the fundamental elements needed for the process; Stages, Gates, Stage activities, Deliverables and Gate criteria but some of them needs to be developed further.

Grönlund et al., (2010) are criticising the stage gate model, declaring that it is too time consuming due to timewasting and bureaucratic procedures and restriction of learning opportunities which are easy to relate to the current process for PC Kalmar and PC Essen. Cooper (2007) explain that it is common that companies are struggling to fit the theoretical process to their organization and therefor modify, adjust and adapt the Stage Gate process in order to make it better, faster and more productive which is also something PC Essen and PC Kalmar have to do in order to be successful. Some examples of improvements done by other companies are applying concurrent activities, overlapping stages and conditional GO-decisions which are all good options to improve the PC Kalmar and PC Essen Process. Adding and/or adjusting the process in this direction would ease the phase transition be more suited for the current process where it depends on where the PDC is situated. The disagreement between the two PCs of the meaning of a deliverable could further be solved by adding the higher level of deliverables, adjusting the process to fit both PCs as supported by Grönlund et al (2010). Thus the creation of main deliverables which will further support the decision making process at the gates, reducing time consuming discussion and steer the focus toward the kill/go/pause decision. These main deliverables can be considered to be the objectives of the project, and thus, as suggested by McLeod (2012), be narrow in scope, specific, concrete, short term and easy to validate. It is further suggested to develop SMARTER objectives which will strengthen the new process and secure the value of the main deliverables. This concept has been agreed on both PCs, and also the main deliverables for the Feasibility study. The main deliverables for the final four phases

are suggested to be developed in the same matter as soon as the deviations and disagreements are solved.

Grönlund et al (2010) describe an updated model called "Next Generation Stage Gate process which is addressing the problem with the old Stage gate process. This new process apply a series of overlapping and fluid stages with conditional-go decisions which are further supported by Cooper (2007). The Next generation Stage gate model would be an advantageous approach to the NPD process and ease the merge of the PC Kalmar process and PC Essen process. Applying Coopers (1994) six F's to the future process for PC Kalmar and PC Essen would strengthen the process considerably. Flexibility, Fuzzy and Fluidity would allow the process to have overlapping stages thus fit the current PDC-gate-process. This approach would also ease the discussion for the two PCs deviation when it comes to front loading versus overlapping, saying that activities can overlap and deliverables be conditionally approved. The stage gate process have been criticised to restrict learning opportunities (Grönland et al, 2010) which could be solved by these overlapping activities. Jespersen (2012) explain that activities can depend on activities in both previous and upcoming stages, thus should not be considered independent information. When activities correlates with other activities in other phases, a branch or a path of information if created which further increase learning.

Adding the Focus would for PC Kalmar and PC Essen signify to develop strong criteria which would support and strengthen the decision making, thus give the gates teeth. The criteria can be considered to be the goals of the project, and should thus, as suggested by McLeod (2012), be qualitative, long term and intangible. The combination of the criteria and the main deliverables, will further strengthen the Focus for the future process for PC Kalmar and PC Essen by analysing the projects both long term/ short term and adding the possibility to prioritize them. The final F (Cooper, 1994), Forever green forces the two PCs to work continuously improve and develop the process, thus demanding them to collaborate and work together.

6.4 Project Maturity

The information received at the start off this thesis, together with previous knowledge of the organization, implied a project management process corresponding to one of the higher maturity levels in the CMM SEI model (Tayntor, 2010). As the thesis preceded and revealed contradicting information, the actual level of maturity have been questioned. Applying the CMM SEI maturity model Tayntor (2010) to the current project management process at Epiroc indicates that the organization yet has a far bit to grow and only fulfill the requirements to reach the second milestone. By examining the project management capabilities several areas to improve in order to reach the next level have been found. Crawford (2014) claim that around 90% of organizations are performing at level 1 or level 2 which also seem to be the case for Epiroc. There is indeed an established basic management process but it lacks the standardization and integration of the processes across the entire organization, hence the deviation of performance between the projects. The deviations and disagreements between PC Kalmar and PC Essen are evidently the biggest obstacles for reaching the next level, thus the importance of the agreement on one standardized process with common deliverables. Having all project management processes in place and established as

standards is one of the criteria for level 3 in the CMM SEI model (Tayntor, 2010) and will thus be fulfilled with the agreed process for both PCs.

Further requirement for maturity level 3 is the consistent involvement from management regarding input and approval of key decisions and project issues as described by Crawford (2014) which are exiting on several levels at Epiroc. The escalation models at both PCs are involving the managers and giving them relevant information about the projects. This process could, however, be integrated deeper into all departments as it has been for production. The monthly PDC meetings are also an advantageous process which involve management and provide the key decision function as described by Crawford (2014). However, as previously discussed, this is a process which can be developed further. To reach level 3, Epiroc also needs to establish a process to compare and evaluate the projects in the light of other projects, not only itself. This can be achieved by implementing the main deliverable level together with the criteria for the gates. Crawford (2014) further emphasis the requirement of a process which can be tailored to all projects and the importance to consider different project characteristics. The Next generation stage gate model (Grönlund et al, 2010) as previously described, provides Epiroc with the opportunity to do so. Applying the six F's by Cooper (1994) and especially Flexibility, Fuzzy and Fluidity creates that essential possibility to adapt the process to the project and not vice versa.

An outset of a foundation for Epiroc to reach level 4 at the CMM SEI scale is already existing and have high potential to improve once the requirements at level 3 are reached. The integration of the project processes to the corporate process and systems, which are level 4 necessities as described by Crawford (2014), are to some extent already implemented. The integration of different software and processes such as PDMlink to SAP for both PCs and the MS Project connection to SAP for cost allocation for PC Essen are some examples of the finance and accounting systems. Once the future standardized process has been agreed upon between the two PCs it is a great opportunity to reach level 4 by further implementation and integration of processes as such.

To completely understand the current level of maturity and areas to improve in the direction of reaching level 3 or even level 4, and consequently improve the organization, an independent assessment as explained by Crawford (2014) is recommended. The independent assessment would be an advantage for Epiroc due to the disagreements within the organization and the process deviation between PC Essen and PC Kalmar. Furthermore is the risk of receiving false result when using the self-assessment as a result of higher ratings for the own process. Due to the current competitiveness and disagreements between the two PCs the independent assessment will further supply an external voice to guide the organization in the right direction, unifying them to, together with the assessors, develop an implementation plan once the result has been presented to the management team.

6.5 Project Outcome

Based on the deviations and disagreements encountered throughout the project, the outcome of the master thesis consists of a proposal standardized new product development process. By proposal it is intended that the process designed for the outcome represents the maximum modification of both current processes into a common one given the actual situation. This proposal therefore includes repositioning

of deliverables and suppression/creation of deliverables for all five phases of the stage gate process e.g: Feasibility Study, Design, Prototype and Testing, Production Preparation and Market Launch.

Achievement of feasibility study phase

The feasibility study phase represents the initial phase of a new product development process where product ideas and their realisation are estimated and for which the initial planning of the entire project with regards to all resources and time is founded. For both product companies, the deliverables present in this phase were somewhat similar and its produced outcome (Master Specification document) was also analogue. The association of both sets of deliverables was thus possible and agreed upon by both parties which lead to a standardized feasibility study phase which is presented in details in results chapter. The nature of the feasibility phase permitted to avoid critical disagreement and deviations between the two product companies since its cost is not imputed into the project budget thus not intervening with the difference in cost allocation structure. Furthermore, the departmental responsibility and project manager role was highly similar for both initial NPD processes which also permitted the achievement of a standardized feasibility study phase. Lastly, being the first phase of the process, the feasibility study phase does not carry any delays, is not subject to any conditional deliverables at its beginning and does not overlap other phases which eased greatly its standardization on a divisional level.

Four subsequent phases

With regards to the four subsequent phases, their complete standardization was unreachable in the current situation. Indeed, past the feasibility study phase, tangible outcome are created to move towards market entry of a final product which thus implies all deviation and disagreement variables mentioned above. Once again, the deviations in cost allocation, project structure, resource planning systems and disagreement with regards to the understanding of stage gate process did not allow for complete standardization of NPD process. Working with these differences between the two product companies, phases following the feasibility study were modified and optimized to the maximum through three iteration of proposals. Deliverables were matched to the possible extent and the remaining were left marked for both product companies to further discuss and decide together in what phase they should be moved or retained. Furthermore, deliverables with different ownership (department responsible for said deliverables) were also marked and left for both parties to jointly agree upon which department should be responsible for such deliverables. Once again, deliverables from both initial processes were supressed upon agreement and deliverables were modified or added again upon agreement from both parties. Although not completely standardized, the work done for the four phases past the feasibility phase is considerable and should therefore be used as foundation work for both product companies to build a complete standardized NPD process when time is right and when deviations and disagreements are aligned.

Introduction of Main deliverables

In order to simplify the standardization and reach an agreement on what was to be presented to the Product Development Council (PDC) when requesting phase transition, main deliverables were introduced and approved (concept explained earlier) for the feasibility study phase. Indeed, six main deliverables were created to serve as update points to request phase transition from the feasibility study to design phase by

grouping all other deliverables into main deliverable category. This concept proposes that only the main deliverables would be presented at the PDC unless unfulfilled, in that case the associated deliverables would be looked at in details. Although reluctantly approved by the product company in Essen, the naming "main deliverables" represents these six updates points and the naming "deliverables" is associated to all other tasks categorized under each main deliverable and representing the complete phase. The results chapter shows the difference between main deliverables and deliverables thoroughly.

6.6 Implementation

In order to implement a standardized new product development process on a divisional level there needs to be an initiative from all parties to accept and work in line with the proposed process being implemented rather than against it. Indeed, in the current situation there is no sense of urgency with regards to the adoption of a standardized NPD process as both product companies currently have well enough functioning processes. Moreover, it has been analysed that until there is actual urgency or until standardization of the NPD process becomes a priority in the HAT division, no concrete initiative or implementation of such process will happen. This goes along side stakeholder management theory stipulating the importance of prioritization of stakeholders and their interest (PMI, 2013). In the current situation, stakeholders of both product companies have other interests to prioritize.

Furthermore, to allow implementation of a standardized process, thorough and very flawless communication has to be in place between the involved parties. In the current situation, there is none or very little communication between the product companies which makes it highly difficult to implement any process changes. The use of workshops gathering DD managers and Project managers from both product companies would be highly efficient as explained and suggested by PMI (2013). By having workshop days with face to face communication, the product company in Kalmar and Essen would better assess and realise the problems encountered with the standardization of the NPD process and could engage in activities such as brainstorms or mind mapping enable quick problem solving and solution development. These suggested workshops would also help build trust between the two parties and lower the resistant behaviour to change currently witnessed.

Based on the previously explained deviation in functional structure, the alignment of Product Company's structural foundation is necessary for the implantation of a shared product development process. By having relatable resource allocation structure on which projects are highly dependent, the implementation of standardized NPD process would be possible at a greater extent than the proposal shown in this thesis. The adaptation of common project management tools through knowledge sharing represents a realizable alignment of functional structure permitting both parties to understand more deeply and relate to how one another perform their project development work.

Following the alignment of mentioned deviations and disagreements, the obvious importance of creating a precise implementation plan is a key milestone in standardizing the NPD process on a divisional level. Indeed, lowering the ambiguities to a minimum and communication such implementation plan to all involved stakeholders (directly or indirectly) represents a strong factor in the success of the

implementation. Furthermore, this implementation has to be done from top management to increase acceptance of the standardized process throughout the organizational structure with consideration of course of all levels and their involvement when creating the standardized process.

The last aspect of this analysis and discussion stands in the openness to change. Indeed, both product companies display a normal behaviour of protection of their own current process and sometimes shown resistance to adapting said current process to a common one. This justifies that all parties involved have to "work with change" rather than against it to allow a standardized new product development process to be designed and implemented throughout the division.

7 RESULT

Due to the deviations and disagreements between PC Essen and PC Kalmar, the final proposal do not contain five finalized and agreed phases. However, the first phase, Feasibility study phase, has been matched and approved from both PCs, and a suggestion with highlighted deviations will be presented for the final four phases. These deliverables are ti be updated depending the future agreement of deviation in process and disagreements between the two PCs. The matching of deliverables are presented by the deliverable nr written in white in the deliverable box, in this thesis presented as X.xxx for Kalmar and X for Essen, see *Figure 53*. If there is one deliverable without an additional number this deliverable has not been matched to another but has been considered valuable for the other PC and hence added to the final proposal. There are some deliverables which have been matched to another deliverable in another phase or is only done once for one PC but several times for the other. These deliverables contain a black text (or pink if the deliverable itself is black) giving the name of the deliverable and explaining where it can be found, see *Figure 54*.

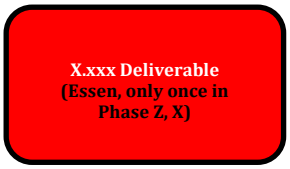

Figure 54 - Matching in other phases

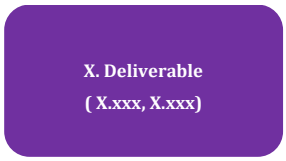

Figure 53 – Matching Example

The final proposal for Feasibility study phase consists of two logical diagrams, (see *Figure 55* and see *Figure 56)*, each containing 34 deliverables where one has the Kalmar names and the other the Essen names. It is suggested that the two PCs together decide common names for the deliverables and name them with the same structure as Kalmar used, X.xxx where X is the phase number and xxx is the deliverables number. All deliverables have been given the colour of the responsible department which is also described in the bottom left corner. There is a need to update the routines for each deliverable in English and due to the matching of several deliverables from one PC to only one deliverable from the other PC.

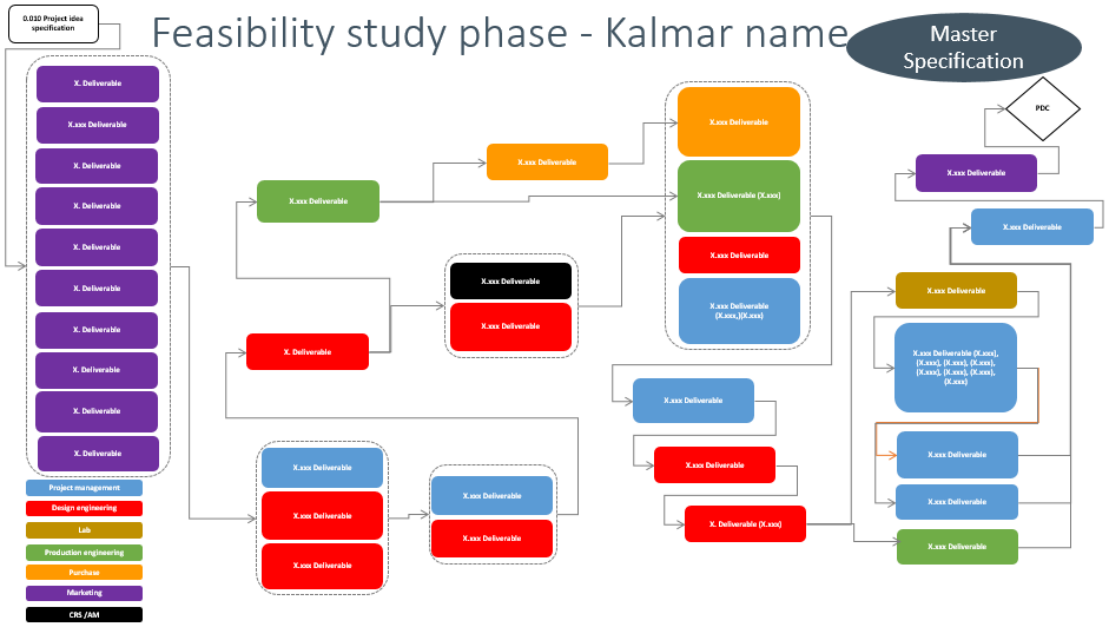

Figure 55- Kalmar feasibility study phase

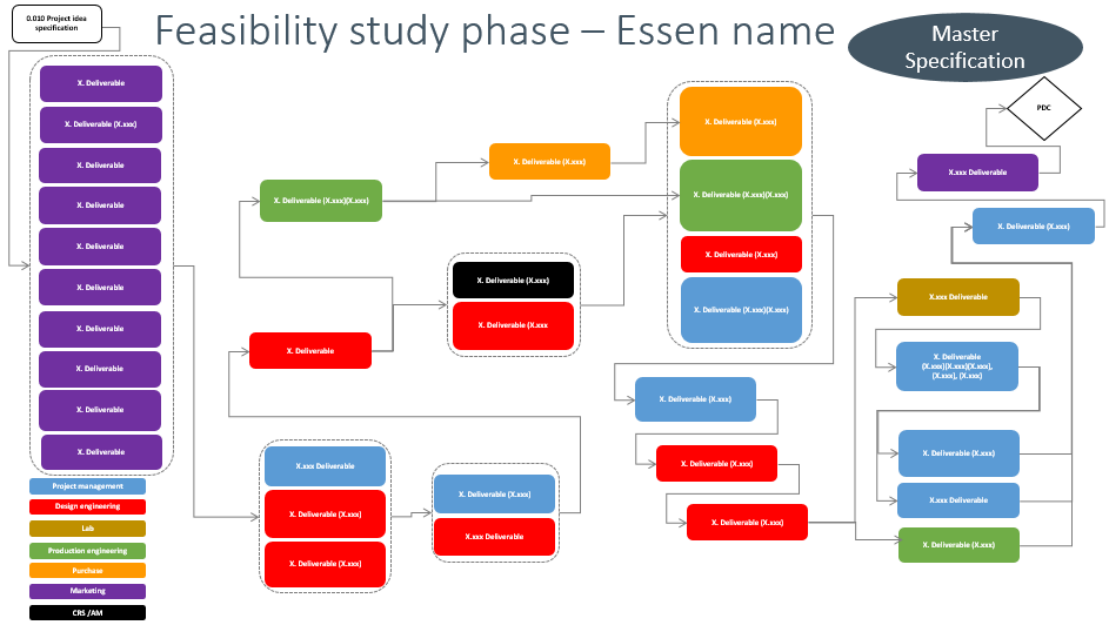

Figure 56 - Essen feasibility study phase

The final proposal for Design phase, as shown in *Figure 57 Design phase*, has several deliverables which are not yet agreed upon due to the deviations. It consists of 17 deliverables in the colour of the responsible departments. There are two deliverables with a yellow frame, highlighting a deviation. These two deliverables are a suggestion of preparation deliverables where Kalmar, due to their front loading approach, have moved deliverables to an earlier phase. Essen only have one deliverable in the upcoming phase. The matching, update and possible move of these deliverables will be possible once the deviations in process and the disagreements have been agreed upon. Furthermore, this phase contain two deliverables in both blue and green. This is again due to the deviation in process where the PM is in charge in Essen and production in

Kalmar. There is also one deliverable striped in red and black due to a disagreement where one PC claim the design engineers to be responsible and the other CRS.

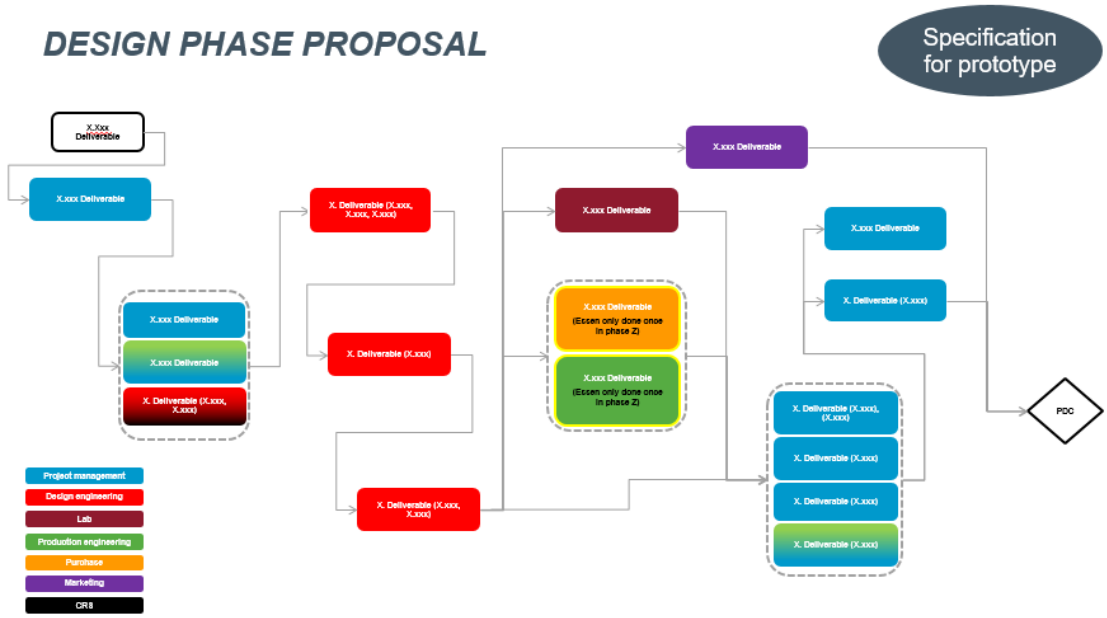

Figure 57 - Design phase

There are 30 deliverable in the final proposal for Prototype and testing phase (see *Figure 58*) making it the largest one. It has seven deliverables with yellow frames to highlighting the deviation and suggestion of preparation/verification deliverables. This phase further includes five deliverables with black frames which marks a matching with deliverables in other phases and cannot be solved before the deviation agreement has been done between PC Kalmar and PC Essen. Again, there are several deliverables with two colours that mark a deviation in responsibility between the two PCs which could not be agreed upon due to the existing deviations and disagreements.

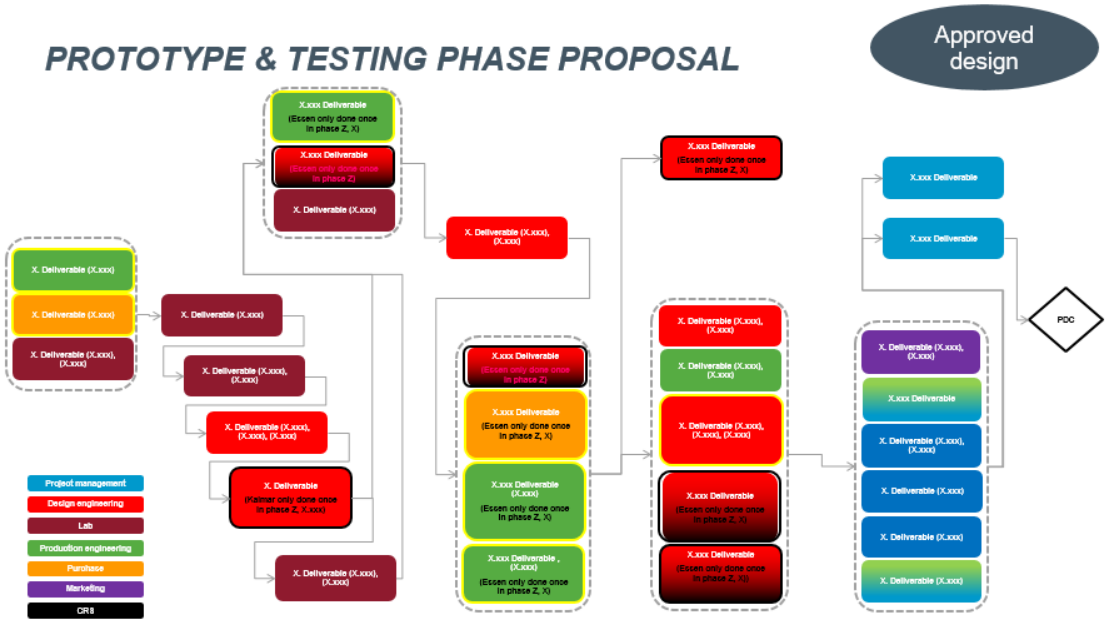

Figure 58 - Prototype and Testing Phase

The Production preparation phase has 23 suggested deliverables in the final proposal where four of them are matched with deliverables in other phases, again marked with black frames, see *Figure 59*. There are four suggestion of preparation/verification deliverables highlighted with yellow frames. This phase has four deliverables with two colours, mainly due to the deviation of PM where Kalmar have a production engineer as PM in this phase and Essen a design engineer.

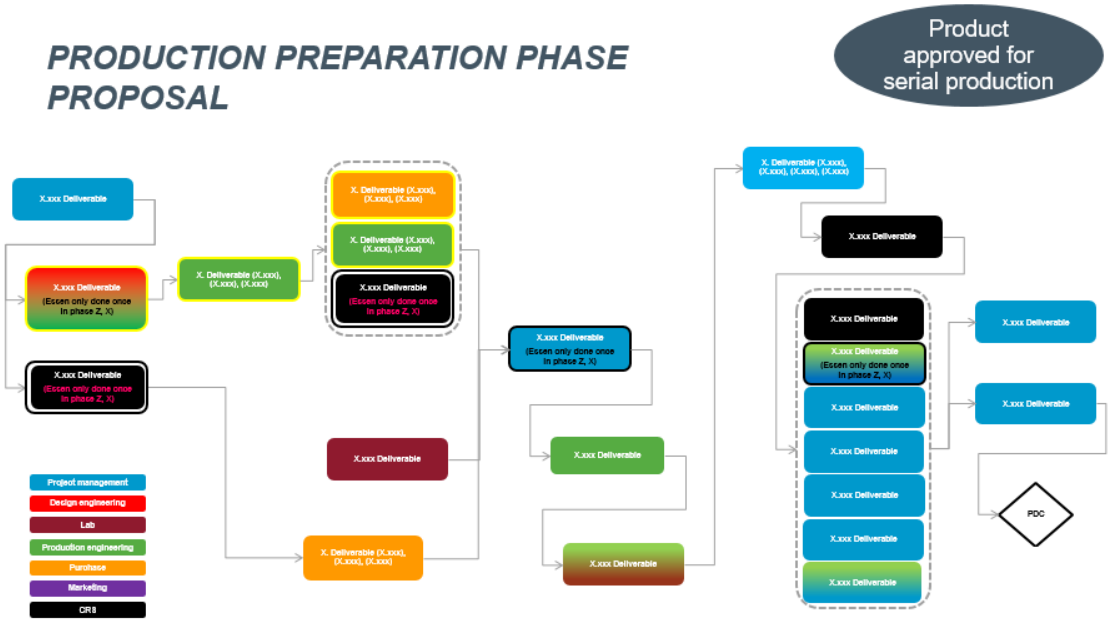

Figure 59 - Production preparation phase

The final proposal for the final phase, the Market launch phase, consists of 25 deliverables, see *Figure 60*. There are five multi coloured deliverables with different responsibilities between the two PCs. This phase further contain two pink deliverables due to a specific department for PC Essen which Kalmar does not have. Finally, there are three black frame deliverables matched with deliverables in the Production preparation phase.

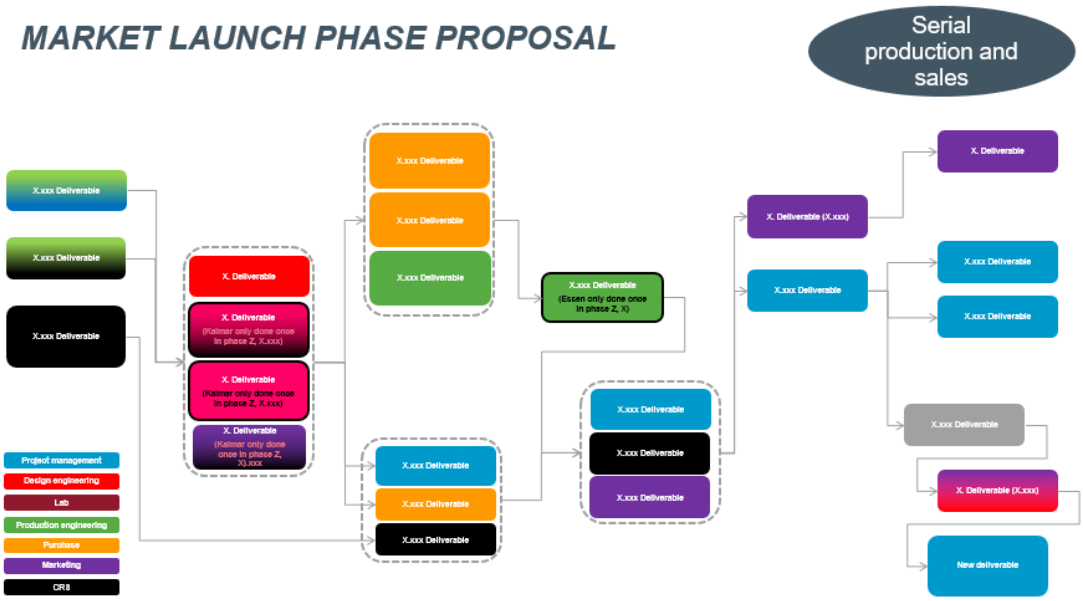

Figure 60 - Market Launch Phase

The concept of a higher level of deliverable, more suited for reporting at PDC, was agreed between the two PCs (see *Figure 61*) but only finalized for the Feasibility Study Phase. There are six Main deliverables for the Feasibility study phase, the remaining phases can have more or less Main deliverables and will depend on the outcome of deliverables in the logical diagram once the deviations and disagreements have been solved. The Main deliverables for the Feasibility study phase are suggested to be used as a model/ inspiration for the final four phases. The naming of the Main deliverables follows the same logic as for the deliverables, *MX.x name* where M stand for Main deliverable, X represent the phase, x is the specific Main deliverable number and finally a descriptive name.

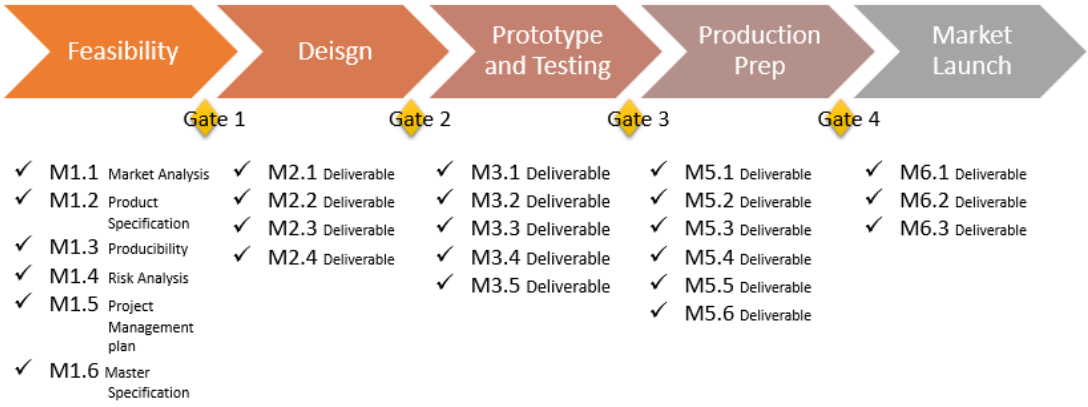

Figure 61 - Main deliverable concept

Each deliverable are categorized under the Main deliverables, as shown in the agreed Feasibility study phase proposal, see *Figure 61*. This proposal has named the Feasibility study phase to "1" and the six Main deliverables have been given descriptive names as seen in the *Figure 62*. Each of the Main deliverables have the categorized deliverables listed underneath them, using names and numbers from the Essen logical diagram proposal, together with the colour of responsible department.

Figure 62 - Main deliverables for feasibility study phase

The first Main deliverable, *M.1.1 Market analysis*, has eight deliverables in its category as shown in *Figure 63.* They are all responsibilities from the Marketing department, but contain activities and tasks for all departments.

Figure 63 - M1.1 Market Analysis

The second Main deliverable, *M1.2 Product Specification*, has eleven categorized deliverables, which are mainly Design engineering responsibilities except for one CRS, one PM and one Lab, see *Figure 64* below.

Figure 64 - M1.2 Product Specification

The third Main deliverable, *M1.3 Producibility*, is mainly the responsibility of the purchasing department and the production department, as seen in *Figure 65.* The Main deliverable has three deliverables in its category.

Figure 65- M1.3 Producibility

The fourth Main deliverable, *M1.4 Risk Analysis*, consists of three PM deliverables as described in *Figure 66* below.

Figure 66 - M1.4 Risk Analysis

The fifth Main deliverable, *M1.5 Project Management Plan*, has five deliverables in its category, mainly with PM responsibilities, see *Figure 67* below.

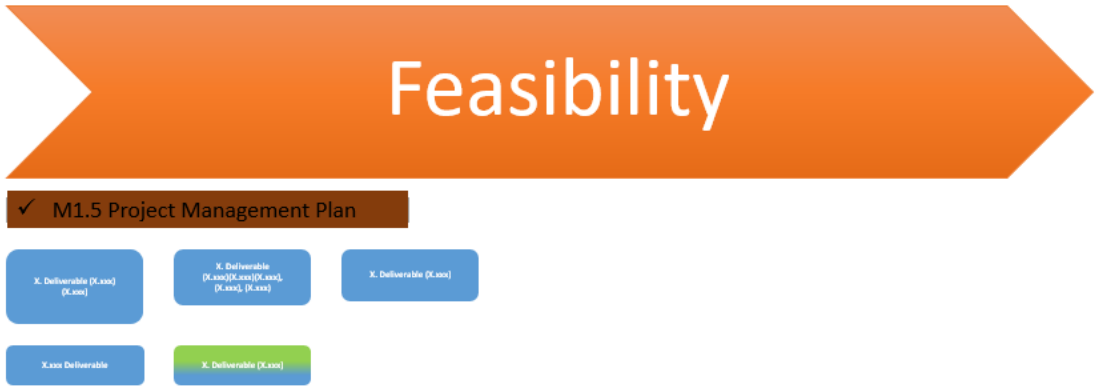

Figure 67 - M1.5 Project Management Plan

The sixth and final Main deliverable, *M1.6 Master Specification*, only has one deliverable in its category and has a shared responsibility between the PM and the Marketing department, see *Figure 68* below.

Figure 68 - M1.6 Master Specification

It is only the Feasibility Study phase that has been completely agreed upon on the logical diagram, the matching of deliverables as responsibilities, Main deliverable names and categorization of deliverables to the Main deliverables. The following four phases needs to be updated once the deviations and disagreements have been solved. This result can be used as a foundation during the workshops and once an agreement is made, update them to fit the decision. The Feasibility study can furthermore function as a guideline. The result does not contain any suggestions for names, except for the agreed Main deliverables for the Feasibility study, which is another thing the two PCs need to agree upon together. There is a recommendation to follow the numbering system as earlier described, but which number to start with should be based on a decision from the two PCs.

8 CONCLUSIONS

This chapter provides the conclusion of this thesis, answer the three research questions and suggest areas to investigate further in the future.

8.1 Standardizing the Project Management Process for New Product Development

There are several benefits of standardizing the project management process for new product development: improved collaboration between PC Kalmar and PC Essen; enhanced the lessons learned process by learning from each other; provide a holistic perspective for employees as to improve departmental responsibilities. However, the standardization will not be possible until the identified deviations and disagreements have been solved.

A standardization of the NPD process for Epiroc on a divisional level would solve several of the key problem areas, and thus improve the process. But this is not possible at this point due to the identified disagreements and deviations between PC Kalmar and PC Essen. The empirical analysis identified departmental responsibilities and the understanding of the deliverables as two of the main issues with the current NPD processes generating the most delays and inefficiencies in projects. Analysis shows that a standardization on a divisional level would dispose these main issues among several other identified problems, such as communication and marketing involvement, thus improve the NPD process. The result displays a foundation of this standardization, suggesting a common structure with matched deliverables for both PCs. However, analysis exhibits several obstacles, mainly in terms of deviations and disagreements caused by the differences in the groundwork upon which the projects are built and executed, preventing a standardization at this point.

The first disadvantage is the utilization of different working structures of the organization between PC Kalmar and PC Essen, primarily the change of PM for PC Kalmar and the way the two PCs appoint responsibility to their project managers differently. Moreover, the different resource allocation processes for PC Kalmar and PC Essen, mainly with regards to cost allocation and use/ integration of ERP system, are another problem area. Furthermore, there is a divergence in flexibility from what is stated in theory between the two PCs which is a central source of disagreement when attempting to design a common new product development process. Finally, the project maturity for the division is at a lower level than anticipated.

In order for the standardization to be possible, these disagreements and deviations need to be agreed upon. The resource allocation process needs to be aligned and the utilization of a common working structure agreed upon. It is necessary for PC Kalmar and PC Essen to involve all stakeholders in the discussion, preferably in the form of workshops, to create the most advantageous process accepted on both sides. On the other hand, the analysis demonstrates that both processes are currently sufficiently enough and hence lacks urgency. Accordingly, the suggested standardization may not be prioritized by Epiroc at this point of time.

8.2 Recommendations for Epiroc

The recommendation for Epiroc, in order to improve the current NPD process, is a standardization of the process by using the agreed feasibility study as a foundation and the following four phases as suggestions to jointly discuss and agree upon. This is to be done by having workshops that includes all stakeholders. Implementing this standardized process would help the division to work as one unit and not as two separate organizations. The standardized process will also function as a safeguard to assure that all projects are executed and progressed in the same way, minimizing the deviations between projects found in the current process. This will give the possibility to compare projects between the two PCs, share resources and strengthen the lessons learned process, thus reducing the delays and improve the efficiencies in projects. A common future NPD process needs to be determined, including to what extent it will follow theory/acceptable deviations from theory. Before this standardized process can be finalized, all previously described deviations and disagreements must be investigated, acknowledged and approved together with the development of an implementation plan pushed down from top management. This will enhance involvement and participation, hence, reduce possible resistance and make sure everyone is on board. In addition, Epiroc has the advantage to use the portfolio manager as the key bridging function between PC Kalmar and PC Essen to reduce the risk of future disagreements and deviations. It is further recommended to continuously work with changes in order to prevent future deviations, disagreements and resistance from stakeholders.

So, there is a great possibility for Epiroc to advance their NPD process by a standardization on a divisional level and thus address and improve several problem areas, mainly departmental responsibilities and the understanding of the deliverables, by applying the proposed and, partly, agreed structure presented in the result. However, this will only be possible when the deviations and disagreements have been agreed upon by including all stakeholders in workshops to settle this matter and to align it into a joint standardized process.

8.3 Further Research

There are several aspects which were not considered in this thesis, but which would be of interest to investigate in the future. Communication is one of the major problem areas identified in the empirical analysis and thus undeniably a valuable area to investigate further. This research could involve the development of a standardized communication plan well suited to future NPD processes. Other interesting areas for Epiroc to investigate further are cultural differences due to the location of PCs in different countries. Finally, change management as a principle for organizational change and to cope with resistance for change.

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10 APPENDIX

10.1 APPENDIX – A –

Interview Release Form

I give my consent for Carolina Hansson and Sébastien Smith to use information from their interview of me for their Master Thesis on NPD processes which will be published publicly at Chalmers University of Technology.

_____ _____

(Print name) (Date)

_____ _____

(Signature) (Date)

I give additional consent for the above named students to use photographs and/or other artifacts in the same thesis.

_____ _____

(Signature) (Date)

Witnessed (if required):

_____ _____

(Print name and relationship to interviewee) (Date)

_____ _____

(Signature) (Date)

10.2 APPENDIX -B-

Table 17 - Data for Statistical Analysis - KALMAR

Dept.	Problem nr. ID	Negative Impact Classification	Problems	1st level Categorization	# of mentions
DD	1	3	Duo function for PM makes it difficult	PM role	1
DD	2	3	Pm should be only PM, not design engineers as well		1
DD	3	5	not communication plans	COMMNUICATION CROSS DEPARTMENT	1
DD	4	5	too much silo work		1
DD	5	5	To many mails, not enough calls		1
DD	6	5	not communication plans	COMMUNICATION DEPARTMENT	1
DD	7	0	only one Design team uses folder structure		1
DD	8	5	To many mails, not enough calls		1
DD	9	5	time is not a key aspect, but everyone should know where they are and what is coming	PROJECT OVERVIEW	1
DD	10	5	clash with lab schedule	PHASE IN/PHASE OUT (prod and prot)	1
DD	11	1	No knowledge share between Kalmar and Essen	COMMUNICATION K & E	1
DD	12	1	no communication plans		1
DD	13	0	K & E never satisfied about each other		1
DD	14	1	Bad communication with Essen		1
DD	15	5	To many mails, not enough calls		1
DD	16	4	deliverable priority	DELIVERABLES	1
DD	17	4	to many deliverables		1
DD	18	2	Too much administration in general		1
DD	19	4	too general routine descriptions		1
DD	20	1	administration is too heavy		1
DD	21	1	Heavy administration		1
DD	22	4	Too many deliverables		1
DD	23	5	Prioritisation of projects in case of lack of resources is not existing		1
DD	24	1	too much status reports in PDC	PDC issues	1
DD	25	1	Hard communication in PDC		1
DD	26	5	PDC cuts estimations that are realistic		1
DD	27	1	PDC is to heavy, uneven depth in the details,		1
DD	28	5	PDC is unrealistic with regards to time and PK		1
DD	29	5	NPD process not fully accepted by everybody	DEPARTMENT RESPONSEBILITIES	1
DD	30	5	More focus on other departmental targets than project targets; ex purchasing		1
DD	31	4	Dep structure is very unclear/vary		1
DD	32	5	ambiguous responsibility when transitioning to production		1

DD	**33**	**5**	time is not a key aspect in epiroc but it must be		**1**
DD	**34**	**4**	Design engineers focus too much on wrong areas of the design		**1**
DD	**35**	**5**	Lack of risk mitigations in feasibility	**Risk analysis/lessons learn**	**1**
DD	**36**	**5**	Too often single design without backup		**1**
DD	**37**	**5**	no backup supplier		**1**
DD	**38**	**5**	No back up prototype		**1**
DD	**39**	**4**	NO risk analysis at all		**1**
DD	**40**	**5**	Large gaps in feasibility study	**Feasibility issues**	**1**
DD	**41**	**5**	Time estimation		**1**
DD	**42**	**5**	Don't start with knowledge gaps.		**1**
DD	**43**	**5**	Time plan is underestimated. always		**1**
DD	**44**	**4**	Design engineers focus too much on wrong areas of the design		**1**
DD	**45**	**5**	resource allocation should be based on realist estimations and not eye-balling		**1**
DD	**46**	**5**	testing phase creates the most looping	**Looping in testing phase**	**1**
DD	**47**	**5**	looping between design and prototyping		**1**
DD	**48**	**5**	Gaps in feasibility study		**1**
DD	**49**	**5**	looping and delays is Lab/prototype and test		**1**
DD	**50**	**4**	Only implemented from VP dd, not on a divisional level	**IMPLEMENTATION NPD**	**1**
DD	**51**	**5**	NPD process not fully accepted by everybody		**1**
DD	**52**	**4**	NPD not implemented nor integrated enough		1
DD	**53**	**3**	perspective: if it not done by us, not good		1
DD	**54**	**5**	Implemented only for half DD depat.		1
DD	**55**	**5**	Marketing needs to give better input	**MARKETING COMMITTMENT**	**1**
DD	**56**	**5**	Marketing only involved in the beginning but then they don't contribute to the rest of the project		1
DD	**57**	**5**	Marketing and CRS not involved at all in project, see them as an expense		1
DD	**58**	**5**	Lack of involvement from marketing		1
DD	**59**	**5**	lack of involvement from marketing		1
DD	**60**	**0**	File server is old-school		1
DD	**61**	**5**	clash with resources due to time delay (people not ready to start with new project)		1
DD	**62**	**5**	projects are always late		1
GM	**63**	**5**	lack of Official PM-roles		1
GM	**64**	**1**	Difficult PDC communication		1
GM	**65**	**5**	Lack of commitment to NPD because it is DD driven		1
GM	**66**	**5**	NO Plan B		1
GM	**67**	**5**	No risk analysis		1
GM	**68**	**5**	Lack of commitment to NPD because it is DD driven		1
GM	**69**	**5**	Has not been top-down implemented		1

GM	**70**	**5**	lack of marketing involvement		1
Prod	**71**	**5**	Slow delivery from purchasing	**PURCHASING PERFORMANCE**	1
Prod	**72**	**5**	No easy way to check status for project		1
Prod	**73**	**5**	Phase in/phase out to production: no check-list to see that everything is completed		1
Prod	**74**	**1**	No idea of what is happening in Germany/how they work		1
Prod	**75**	**1**	No communication between essen/kalmar production		1
Prod	**76**	**1**	heavy administration		1
Prod	**77**	**1**	Decision making in PDC in unclear		1
Prod	**78**	**1**	PDC is tricky to follow, and to understand what decisions that are made		1
Prod	**79**	**4**	too much ownership from DD		1
Prod	**80**	**5**	gaps in the deliverable-responsibility		1
Prod	**81**	**5**	unclear documentation structure/recording process		1
Prod	**82**	**4**	No lessons learned		1
Prod	**83**	**5**	Looping design-prototype which is not accounted for in feasibility plan.		1
Prod	**84**	**5**	lack of sufficient master specification		1
Prod	**85**	**5**	time estimation in feasibility is bad		1
Prod	**86**	**5**	Testing is most likely to have problems		1
Prod	**87**	**5**	time schedule does not take loops into consideration (prototype and testing		1
Prod	**88**	**5**	unclear documentation structure/recording process		1
Prod	**89**	**5**	Lack of marketing involvement		1
Prod	**90**	**5**	lack of marketing and CRS in the stage gate process		1
Prod	**91**	**5**	NO interaction with marketing		1
Prod	**92**	**5**	not enough resources		1
Purch	**93**	**5**	Kalmar: Purchasing exceeds time schedule		1
Purch	**94**	**5**	weak knowledge of new suppliers		1
Purch	**95**	**3**	Not having ONE PM		1
Purch	**96**	**5**	lack of involvement of purchasing early in stage of project		1
Purch	**97**	**1**	purch Kalmar need more communication and collaboration with Essen		1
Purch	**98**	**1**	heavy administration		1
Purch	**99**	**5**	There are grey areas with no deliverable responsibility		1
Purch	**100**	**1**	PDC needs more discipline		1
Purch	**101**	**2**	double documentation		1
Purch	**102**	**5**	Purchasing needs a better feasibility study/master spec to find good suppliers		1
Purch	**103**	**5**	Underestimation of supplier delivering time (from DD)		1
Purch	**104**	**5**	No-one in Purchasing uses the NPD process, but their own strategy should cover the deliverables?		1
Purch	**105**	**5**	marketing is not involved enough		1

Table 18 - Data for Statistical Analysis - ESSEN

Dept.	Problem nr. ID	Negative Impact classification	Problems	1st level Categorisation	# of mentions
DD	1	3	No official meeting structure		
DD	2	3	No official meeting structure	COMMNUICATION CROSS DEPARTMENT	2
DD	3	2	Communication about resources		1
DD	4	4	People are not automatically sharing information, everyone always need to fish for it.		1
DD	5	1	No sharing with Kalmar at all,	COMMUNICATION K & E	1
DD	6	1	Different NPD implemented		1
DD	7	1	Not in the loop of decision making		1
DD	8	1	Everything that is officialised is Kalmar oriented		1
DD	9	1	There is a lot of politics		1
DD	10	1	Many things are done in Sweden but not presented or communicated, changes etc in Essen. Ex, deliverables		1
DD	11	2	"Double job"		1
DD	12	3	Pm/authority/commitment	DEPARTMENT RESPONSEBILITIES	1
DD	13	2	have to fish for information		1
DD	14	1	Every meeting s as good as the people attending (commitment)		1
DD	15	4	When something is done, changed or updated, it is not updated at all places.		1
DD	16	4	Implementation of deliverables does not come from top in other dept. but from DD. hence, not accepted	IMPLEMENTATION NPD	
DD	17	4	things are not implemented in a structured way top -> down		1
DD	18	5	No deliverables for other departments -> struggle when other departments have to contribute	DELIVERABLES	1
DD	19	4	Implementation of deliverables does not come from top in other dept. but from DD. hence, not accepted		1
DD	20	1	not the same deliverables as Kalmar		1
DD	21	1	Deliverables are not structured the same		1
DD	22	5	Purchase is the biggest project risk concerning time and PK (project cost) (needed to get approved in PDC) Resources?	PURCHASING PERFORMANCE	1
DD	23	5	purchasing is understaffed		1
DD	24	5	Purchasing is very under staffed		1
DD	25	5	Input from marketing missing (masterspec written by himself, market analysis by himself)	MARKETING COMMITTMENT	1
DD	26	5	Decrease of marketing involvement		1
DD	27	5	Marketing is not doing the master spec		1

DD	**28**	**5**	Clear definition of the phase in/out is missing. What has to be done? You know what to do but needs to be defined and documented.	**PHASE IN/PHASE OUT**	**1**
DD	**29**	**3**	Risk analysis	**RISK ANALYSIS/LESSONS LEARNED**	**1**
DD	**30**	**3**	Risk analysis today is damage control, not a proper risk analysis		1
DD	**31**	**2**	No structure for lesson learned		1
DD	**32**	**3**	no risk analysis		2
DD	**33**	**2**	No real documentation of lessons learned		1
GM	**34**	**1**	The main problem between K&E is that they don't communicate. They are always in competition which they really shouldn't be		1
GM	**35**	**5**	Input for marketing = very poor (ex: Bad forecasting from Marketing) Ex: SDTs: when you sell only 7 units a year but all orders at the same time…. late on delivery due to no stock and no realistic forecast.		1
GM	**36**	**5**	Marketing needs to give better input to D&D and Production and more frequently and as much as possible.		1
M	**37**	**5**	lack of communication everywhere	**COMMUNICATION DEPARTMENT**	**1**
M	**38**	**4**	M feel Always have to ask, no follow up in project.		1
M	**39**	**2**	Don't understand Gibraltar		1
M	**40**	**5**	Both lack of resource and also Process. Miscommunication between DD and Purchasing. Purchasing don't get the new drawing, when done, go and ask.		1
M	**41**	**4**	Have to call for all the status within all projects		1
M	**42**	**2**	Gibraltar: does not work. can change everything, no official non-changeable program		1
M	**43**	**5**	Big black box for marketing between master spec - market launch		1
M	**44**	**5**	There is NO communication		1
M	**45**	**4**	DD finish, drawing is released in SAP, needs some kind of confirmation that Purchasing has received it.		1
M	**46**	**5**	Both lack of resource and also Process. Miscommunication between DD and Purchasing. Purchasing don't get the new drawing, when done, go and ask.		1
M	**47**	**4**	No meeting, only email to get information (marketing) for closing report		1

M	**48**	**4**	Departments don't know how the other departments work, what they know or what is important for them		1
M	**49**	**4**	Every person has their own different supposedly structured meetings.		1
M	**50**	**5**	Departments work too much in silo		1
M	**51**	**5**	lack of communication everywhere		1
M	**52**	**3**	No top down guidelines - both Kalmar and Essen create their own way/things		1
M	**53**	**1**	K and E don't feel involved in the other		1
M	**54**	**5**	lack of communication everywhere		1
M	**55**	**3**	mark things DD needs clear guidelines on how to run the projects		1
M	**56**	**5**	Departments don't know how the other departments work, what they know or what is important for them		1
M	**57**	**5**	Mngmt. is not familiar with NPD deliverables it at all		1
M	**58**	**2**	Marketing treats K and E equally and therefore need the standardized process		1
M	**59**	**5**	purchasing		1
M	**60**	**5**	Purchasing needs more resources		1
M	**61**	**3**	Marketing wants to be more involved during project		1
M	**62**	**3**	Market launch, only market dep involved.		1
M	**63**	**3**	Before: Don't have time to work on internal things -> input not good enough		1
M	**64**	**3**	administration is heavy for marketing		1
M	**65**	**5**	Priority deviation when entering stage transitions		1
M	**66**	**0**	Kalmar is a little bit off the spot (everything is in Essen)		1
M	**67**	**5**	Have to call for all the status within all projects		1
PROD. log	**68**	**0**	Kalmar and Essen use SAP different?		1
PROD. log	**69**	**4**	Logistics Not involved at all in NPD stage gate process with deliverables		1
PROD. log	**70**	**5**	Forecast from marketing		1
PROD. log	**71**	**0**	There is no difference between new product production and serial production or any other production. they just follow the production orders regardless of what it is.		1
PROD. log	**72**	**3**	Risk analysis- plan b routing		1
PROD. log	**73**	**4**	no risk analysis		1
PROD. plan	**74**	**5**	Production is not involved at all.		1

PROD. plan	**75**	**5**	PROD Don't know about the deliverables		1
PROD. plan	**76**	**5**	PURCH Capacity		1
PROD.log	**77**	**5**	Logistics Not involved at all in NPD stage gate process with deliverables		1
Purch	**78**	**5**	More involvement needed for Purchasing in the design phase: is it possible? welding tests, doubts, can it be produced? contact suppliers		1
Purch	**79**	**5**	PURCH Not aware of the deliverables involved in the NPD. Purchasing gives input for MasterSpec only upon DD's requests and inquiry		1
Purch	**80**	**5**	More involvement needed for Purchasing in the design phase: is it possible? welding tests, doubts, can it be produced? contact suppliers		1
Purch	**81**	**5**	Major issue: Phase out process for product changes. Purch needs earlier heads up from marketing when they change product types.		1
Purch	**82**	**3**	Dont document lessons learned ; ex be there when new supplier welds a product for the first time		1
Purch	**83**	**0**	Difficult if they don't mention ID-nr! hard to follow'		1
Purch	**84**	**5**	No clear idea of complete time-line for projects	**PROJECT OVERVIEW**	**1**
Purch	**85**	**5**	Part come here and are booked in, She needs to check SAP by herself. No automatically message if there is a quality issue .		1
Purch	**86**	**4**	departments don't feel ownership		1
Purch	**87**	**4**	hand over from previous colleague		1
Purch	**88**	**5**	No clear responsibilities; ex Who orders small "in stock products"?		1
Purch	**89**	**5**	Purch want to be More informed about process		1
Purch	**90**	**5**	NOT aware at all of deliverables		1
Purch	**91**	**5**	No structured process for purch		1
Purch	**92**	**4**	No risk analysis or DOCUMENTATION of lessons learned		2