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JESSE MAKKONEN

RAMPING UP SITE MANAGEMENT FUNCTION

Master of Science Thesis

Examiner: Assistant Professor Tuomas Ahola and Professor. Jussi Heikkilä
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ABSTRACT

JESSE MAKKONEN: RAMPING UP SITE MANAGEMENT FUNCTION
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The costs of the commissioning have increased in recent years and have cause a lot of additional costs. In the literature, there are not so many topics regarding the commissioning. Based on these reasons, this thesis work aims to find the answers to the following research questions: "For which projects is site management most crucial?" and "Which kind of tasks the site manager should execute for improving the site management function?". A project management process of The Case Company has been used for defining and analysing this thesis work.

First, the work focuses on project management theory. The theoretical section takes part in the theory of project management, project closure, commissioning global projects and teamwork. The empirical part of the work analyses the data of enterprise resource planning system (ERP) that are most critical to the commissioning and what kind of issues lead to higher commissioning costs.
In the second empirical part of the work, four projects have been selected for more detailed research. The target was to interview the project persons and to improve the job description of the site manager to be clearer and meet the needs of the company. A total of 13 project workers participated in the interview.

The results show that the different types of projects have a direct impact on the increased costs of the commissioning of the project, for example the quality of the customer, the duration of the cooperation, the complexity of the project and the work culture. The study noted how each of these issues have a direct impact on the final cost of the commissioning and how successful the commissioning will be. During the interviews, it emerged that the site management is challenging and does not fill the existing requirements. The interviews are based on the project process of the company and their respective commissioning stages, and the interviewees provided many suggestions on development targets, such as the role of the site manager in safety, management and logistics.

The interview study also produced other improvement suggestions for the Case Company. In addition, several development targets were found in the commissioning process which can boost the Case Company to decrease the commissioning costs.

TIIVISTELMÄ

JESSE MAKKONEN: Työmaajohtamisen kehittäminen
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Käyttöönoton kustannukset ovat nousseet viimeisten vuosien aikana kasvaneet ja aiheuttaneet paljon kustannuksia. Kirjallisuudessakaan käyttöönotot ovat aihe, josta ei hirveästi löydy materiaalia. Näiden syiden pohjalta tämä diplomityö pyrkii etsimään vastauksia seuraaviin tutkimuskysymyksiin: "*Minkälaisille projekteille työmaajohtaminen on kaikista tärkeintä*?" ja "*Minkälaisia työtehtäviä työmaapäällikön tarvitsee tehdä työmaalla kehittääkseen työmaajohtamista?"* Tutkimuskysymysten määrittelyssä ja analyysissä on käytetty kohdeyrityksen projektinhallintaprosessia apuna.

Ensin työssä paneudutaan projektinhallinnan teoriaan. Teoriaosassa käydään läpi projektijohtamiseen, projektin päättämiseen, käyttöönottoon, globaaleihin projekteihin ja tiimeihin liittyvää teoriaa. Työn empiirisessä osassa analysoidaan toiminnanohjausjärjestelmän datan avulla millaiset projektityypit ovat kaikista kriittisimpiä käyttöönoton suhteen ja millaiset asiat johtavat käyttöönottokustannusten nousuun. Työn toisessa empiirisessä osiossa on valittu neljä projektia tarkempaan tutkimukseen. Tavoitteena oli haastatella projektihenkilöt läpi ja kehittää työmaajohtajan toimenkuvaa entistä paremmin ja selkeämmin täyttämään tämän hetken vaatimukset. Haastattelututkimukseen osallistui yhteensä 13 projektityöntekijää.

Tulokset kertovat, että eri projektityypeillä on suora vaikutus projektin käyttöönottokustannusten nousuun ja siihen vaikuttavat esimerkiksi asiakkaan laatu, yhteistyön kesto, projektin kompleksisuus ja työkulttuuri. Tutkimuksessa huomattiin, kuinka jokaisella näistä asioista on suora vaikutus käyttöönoton loppukustannuksiin ja siihen, kuinka hyvin käyttöönotto tulee onnistumaan. Työn haastatteluvaiheessa tuli ilmi, että koko työmaajohdon toimenkuvassa on haasteita, eikä se täytä tämän hetken vaatimuksia. Haastatteluissa käytiin läpi kohdeyrityksen projektiprosessin mukaiset käyttöönoton vaiheet ja haastateltavat antoivat monia ehdotuksia kehityskohteista liittyen esimerkiksi työmaajohtajan rooliin turvallisuudessa, johtamisessa ja logistiikassa.

Haastattelututkimus tuotti myös muita parannusehdotuksia kohdeyritykselle hyödynnettäväksi. Lisäksi käyttöönottoprosessista löytyi useita kehityskohteita, joihin panostamalla kohdeyritys voi tehostaa käyttöönoton kustannusten pienentämisprojektia.

PREFACE

The student life in Tampere University of Technology has been the best time of my life and I am finishing my journey with this thesis. During these years, I have met new friends for lifetime. It feels great to reach this point after hard work.

Especially, I would like to thank professors Tuomas Ahola and Jussi Heikkilä for priceless help with this thesis. Also, I would like to thank The Case Company's employees Tommi Koskinen, Ismo Malinen and Leif Backman for providing me with this opportunity and for supporting me during the process.

Last but not least, I would like to thank my family and my important ones for supporting me during my studies. The road was rocky but rewarding.

Helsingborg, 18.11.2018

Jesse Makkonen

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LIST OF SYMBOLS AND ABBREVIATIONS

TUT	Tampere University of Technology
SAP	System, Application & Products in Data processing
ERP software	Enterprise Recourse Planning software
WBS	Work Breakdown Structure
PERT	Program Evaluation and Review Technique
PMI	Project Management Institute
IPMA	International Project Management Association
TNP	Transnational Projects
R&D	Research and development
OTD	On-time delivery
KOM	Kick-off meeting
FAT	Factory acceptance test
HAT	Harbour acceptance test
SAT	Sea acceptance test
HSE	Health safety and environment
MOM	Minutes of the meeting template

1 INTRODUCTION

The newbuilding segment of the marine industry is increasing globally after a period of low profile. Especially cruise and icebreaker business is booming up. The reason for the booming is that the cruise vessel business has spread out to new areas. Earlier, the main cruise markets were located in the Caribbean where the wealthy people were willing to pay extra for the luxurious cruise experience. Now the new markets are spread to Europe and Asia. This causes a need for new vessels to meet the increasing market demand. The low interest level motivates the cruise companies to invest to the new vessels and the recession of the beginning of the 21st century offers low cost workforce for the shipyards. The boom in the vessel construction markets affects the marine industry countries like Finland. The foreign companies are investing to Finland. The new owners of the shipyard of Turku have brought lots of new projects and have made lots of new investments. This also improves the businesses of the sub suppliers of the shipyards. (Investing in Finland)

Globalization and tight markets are making the shipbuilding businesses tougher. The oil price collapsed, and it forced the shipyards to find new opportunities. The shipyards want to keep their current market shares. This has forced the shipyards which used to build offshore vessels to find new opportunities from other market segments. The competition between different shipyards has forced the shipyards to focus on flexibility, customer satisfaction, high tech solutions and quality to gain competitive advantage. This also reflects on the sub suppliers. They need to develop their systems and processes to respond to the market situation.

1.1 The Case Company

The Case Company afterwards referred as The Company is a global marine company which delivers projects for the shipbuilding industry. The Company has more than 500 employees divided to business units around the world. The European Union considers The Company as large company. The company offers a variety of products, systems and services for different kind of marine solutions. The biggest deliveries are system deliveries for the new building section. These systems are worth of tens of millions and the lead time is couple of years. To achieve better efficiency and reliability in the booming markets The Company has started to offer software-based solutions. Also, service business is one of the cores of The Company.

The business segment of The Company can be defined as niche. The number of rivals is low. The entrance level to the market is high. The Company has protected the market lead with specified patents. If a rival wants to step in to the markets, it demands big investments and knowledge of high technology. High technology also fills the needs of the customers and that is why the customers are ready to pay for high technology equipment. (Kotler & Keller 2012).

1.2 Research Background

This thesis has been written for the project execution department of the new building projects. The project execution department has full responsibility of project leading, financial administration, commissioning and customer management. Normally, a project demands co-operation from two to four different internal departments. The spearhead products of the system are produced by The Company owned factories. This guarantees better system modifications, maintenance and lifetime support for the systems increasing the Company's competitive advantage. The on-going new building projects are located around the world.

The Company works in a high competition business area, but the competitive advantage is a result from dissimilarity of the products. The strategy of The Company is to provide high technology systems for marine industry with high quality on time. The management of The Company is commanded to execute cost savings, but at the same time the prices of the suppliers are rising at the global markets. The costs of the projects are increasing and there are few bargain possibilities in the prices of the suppliers. The Company tries to keep the gross profits the same and the customers are pushing the prices of the products down referring to the competition of the markets. This has forced The Company to develop their processes to keep the gross profits. One of the most potential processes is site management, because the costs have increased and some short-term actions are possible to execute.

The goal of this thesis is to develop site management function to respond to the market changes and create extra savings for the projects. The site management function can be defined as the development of the management of the commissioning phase. Now the costs of the commissioning phase are increased and the gross profits of multiple projects have decreased because of increased commissioning costs. The Company believes that by developing the processes it is possible to make savings. The site management function possibly is the one of the low hanging fruits and developing it will make savings, improve customer satisfaction and improve the commissioning process. The site management is a quite new topic in the literature. There are only few publications about the site management. Most of the literature topics focus on developing the earlier phases of the process of the project.

1.3 Scope of Research

Figure 1 illustrates the structure of a typical project execution process. The Company's organization structure consists of three different departments which execute the mutual projects from their own perspective. A simplified description of the project structure is that the sales teams sell the project, project teams execute the project and warranty teams handle all the warranty claims of the end users. This thesis focuses to improve the commissioning phase of the project (Figure 1). The commissioning phase is one of the final phases of the project structure. The function of the site management is to lead the commissioning part of the project. Site management main functions are handling the communication between the site team and the office, leading the site team and being the preliminary contact point for the customer. Normally, it is site manager's duty to handle all these tasks and lead the site. The responsibility of the commissioning remains at the project manager, but the site manager's job is to help project manager at the site.

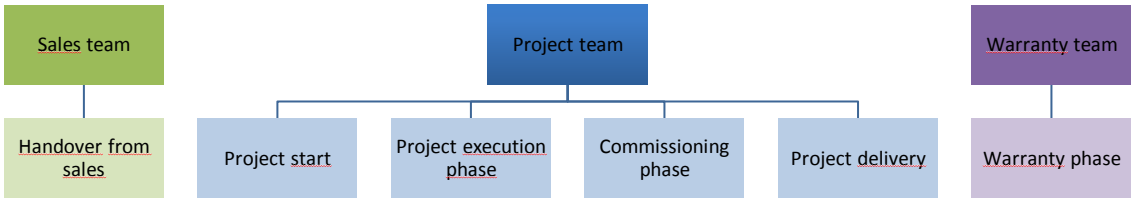

Figure 1. *Structure of project execution process*

Previously, the site manager role of the project execution process was not clearly specified. The main idea of this thesis is to identify if specified site management could give more additional value to the project. The commissioning costs have increased, and the commissioning phase is the most challenging phase in the project process, because the commissioning happens at a customer's site, normally located abroad. During the project execution phase there are mistakes happening such as engineering mistakes or wrongly selected products.

1.4 Research questions and objectives

The target of this thesis is to improve the commissioning phase and reduce the costs of the commissioning phase. This thesis will approach the goals with the following two research questions:

1. For which projects is site management most crucial?

To be able to answer this question, we must investigate what are the total commissioning costs of the projects and what kind of features of the project are increasing the total commissioning costs. It is possible to collect costs from the enterprise resource planning (ERP) system, but the data is not fully reliable. Often the costs are allocated to a wrong work breakdown structure (WBS) – an element in the ERP system.

The total commissioning costs of the project need to be clarified before it is possible to get reliable data from the ERP. After collecting total costs of the commissioning phase, the most critical projects regarding the commissioning phase can be identified. If there are defected project types, it is important to find and clarify those for the detailed analysing. The second research question is linked to this phase.

2. Which kind of tasks the site manager should execute for improving the site management function?

The second research question relates strongly to the findings of the first research question. New tasks need to be found or the current ones need to be developed. These tasks might help the job of the site manager to respond to the rising costs of the project and decrease the commissioning costs of the project. To be able to answer this question, a survey has been arranged. The survey contains interviews of project and commissioning teams of different projects to find out root causes for the reason of overruns of the commissioning budget. After finding the actual root causes, the tasks of the site manager can be developed.

1.5 Research methodology and structure of the research

This chapter contains theoretical background for the study and provides initial data for the research. This thesis work follows the guidelines of an applied case study research. The purpose of this thesis is to find answers for the specific problem in the site management. The writer of this thesis works at The Company and he has commissioning work experience to support this research. The thesis aims to introduce the theory of the project management and the theory of the commissioning phase of the project and the findings are applied to The Company, hence the approach could be called deductive. (Yin 2003; Saunders et al. 2009; Holström et al 2009)

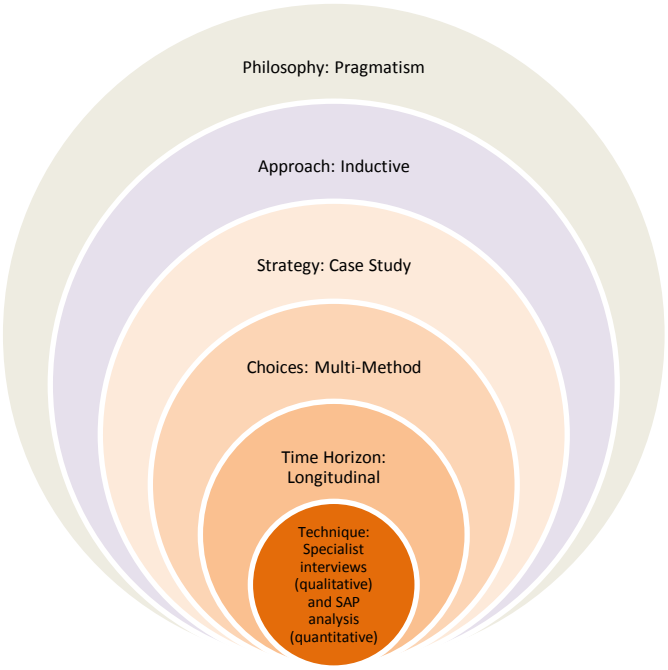

Figure 2. *The research model*

A research is like an onion which contains different layers. Figure 2 presents the onion of this research study. The philosophy is like a way in which you view the world. The philosophy of this research is pragmatism. Pragmatism argues that the most important determinant of the research is the research question. If the answers to the research question can be analysed using a positivist or interpretivist philosophy, this confirms the pragmatist's view is perfectly possible to work with. The best approach is inductive for a study if events are taking a place. (Yin 2003; Saunders et al. 2009; Holström et al 2009)

Literature defines case study as a research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence. Case study strategy also gives answers to questions why. Yin divides case study in different scenarios: single case vs. multiple cases and holistic case vs. embedded case. This research can be categorized as a multiple cases scenario, because there is more than one case. Multiple cases will be compared and target is to find a common factor. Also, this research is a holistic case study because it concerns only the organisation as a whole. The data is collected by using multiple different data collection techniques so the multiple method is selected. The Time Horizon is more like a diary than a short snapshot. That is the reason why the longitudinal time horizon is selected. (Yin 2003; Saunders et al. 2009)

The first part of this thesis is the theoretical part which considers the theory of the project management and the theory of the commissioning. This part's data is collected from journals and literature. The second and the third part of this thesis are related to empirical research, which investigates the problems of The Company. The second part of this thesis is a quantitative data analysis based on the data from The Company's databases. The raw data will be processed to find the answers to the first research question. The third part of this thesis is a qualitative survey which aims to find answers to the second research question. (Saunders et al. 2009)

The fourth part of the thesis presents the project process of The Company. It describes the project organization and the project structure. The end parts of the project process are in the focus. The fifth and the sixth part contain the empirical part of the study. These parts concentrate on evaluating the data analysis and the results of the survey. The recommendations are presented in the final and the seventh part of the study.

2 THEORICAL BACKGROUND

2.1 History of project management

Throughout the history of the humankind people have worked together towards to mutual goals. People have executed huge construction projects, for example more than 4000 years old Great Wall of China, Egyptian Pyramids, Roman roads and Roman aqueducts. The methods to execute these projects were more primitive, but the basic management tools were used back then in a similar way as today's project planning, scheduling, task definition and control techniques. These methods created the foundation for today's project management system (Thamhain 2014). Projects are not always constructions. Another type of projects is for example huge cultural strategies like English Magna Carta and United States Social Security Program. Also, literature projects such as Finland's National Epic Kalevala are included to these definitions (Cleland & Gareis 2010).

Military industry created the basis of modern project management during the World War II. Multiple huge projects like Manhattan Project and German Missile Program were led. In the 1950's, once the technology and targets became too complex, the industry noticed that some projects like the huge missile project Polaris were impossible to be executed because the size of the project. The price tag of the Polaris project was over 11 billion dollars and it was the biggest project in US government's history. The year 1956 has been identified as the beginning of the time of the modern project management. (Thamhain 2014)

The leading engineers of the Polaris project had to develop new project management methods because of the high level of the complexity of the projects, the huge number of subcontractors, the new technology and multidisciplinary skills requirements. Also, the management team was pushing the project team with the schedule. The project leaders of the Polaris project established a new team. This team had full authority over all teams and no responsibilities for normal work process through the approvals of administration. This new dynamic and the method of two teams leading changed the hierarchy of the project. The work flow became more fluent and the project was led with more specific integrated management. Nowadays this method is called matrix hierarchy. The projects of 1950's created lots of new project management tools which are still used, for example Program Evaluation and Review Technique (PERT) and WBS method. (Thamhain 2014)

The modern project management took a notorious step forward once NASA launched the APOLLO project. The scope of the project covered more than 20 000 subcontractors, 400 000 workers and co-operation with over 200 universities. NASA recognized that the scope of the project was too wide to be managed with current project management tools. This caused lots of new management innovations which later defined the frames for the

modern project management including cross functional teamwork and hybrid organizations. NASA developed multiple project management tools which are used in today's project execution processes. (Thamhain 2014; Crowder & Friess 2014)

Nowadays the universal project management follows strict rules. International associations like Project Management Institute (PMI) and International Project Management Association (IPMA) have defined the term "project management" for their members using knowledge and baselines. For example, the PMI has set nine different categories for the baselines of the project management:

- Project time management
- Project cost management
- Project quality management
- Project scope management
- Project risk management
- Project procurement management
- Project quality management
- Project human resources management
- Project integration management. (Cleland & Gareis 2010)

2.2 Global projects

In the literature, there are many definitions for the concept of project. Depending on the context, a project can mean a temporary organization, a target-oriented way to work, a limited series of tasks or problem solving with a tight schedule. Nevertheless, these three points of views for the concept of project have become common representations in literature (Figure 3). (Artto et al. 2006)

Temporary organization means that the project organization will be founded at the beginning of the project and it will be taken down when the project is completed. It is important to find the most suitable team members for specific projects and the meaning of individual responsibilities is high. (Artto et al. 2006)

Product and process structure states that the output product is possible to demolish to sub-products. The sub-products and the process work can be modelled as one hierarchical structure. Hierarchical structure makes process analysing easier because it is more effortless to analyse each sub-part separately than the whole project. Also, hierarchical structure enables WBS. A clear and simple WBS makes project tracking in the ERP system simple. (Artto et al. 2006)

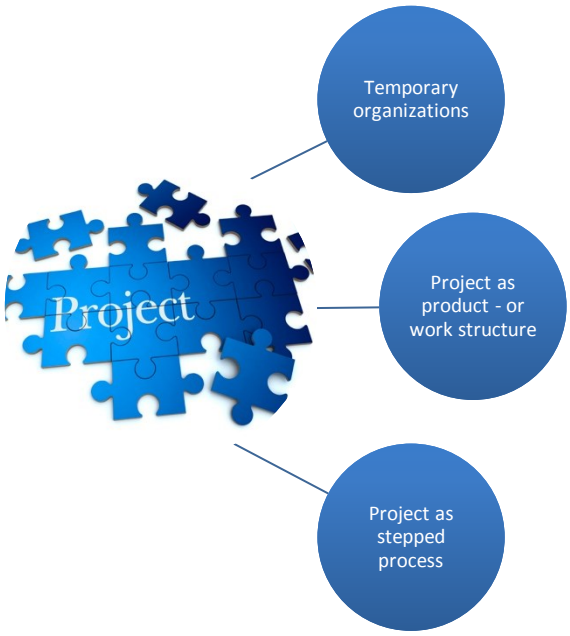

Figure 3. *Three definitions of a project* (Artto et al. 2006)

Project as stepped process suggests that the schedule of the project is possible to be defined when the structure of the process is well described and it is also possible to find reliance between the project steps. This improves the project planning and tracking. (Artto et al. 2006)

Cleland and Ireland define the project in their book "Project management" as *"a combination of organizational resources pulled together to create something that did not previously exist and that will provide a performance capability in the design and execution of organizational strategies. Project has a distinct life cycle, starting with an idea and progressing through design, engineering, and manufacturing or construction through use by project owner"* (Cleland & Ireland 2006)

Regardless of the definition of the concept, fundamental questions are:

- How long will the project execution take?
- How much will it cost?
- What kind of technical performance will the project provide?
- How will the results of the project unite to the design and to the organizational strategy?

It is important to answer to the questions above, because the answers form the basic structure for the project and consider what kind of resources the organization should use. The answers should also fit to the organization's operational and long-time strategies. (Cleland & Ireland 2006)

Cleland and Ireland divide projects which are executed nationally to two different groups - Global Projects and Transnational Projects (TNP). These types have many common characteristics but are not completely same. Global projects are typically big and complex and involve many countries. TNP projects are also spread across the national boundaries, but their scope is narrower. The travelling across the boundaries causes always costs and some places are so isolated that the travelling becomes inconvenient or excessively expensive. This research focuses on TNP projects. The TNP projects can be divided to four different types regarding the amount of the sites and the number of related organizations. (Figure 4.) (Cleland & Ireland 2007)

Type 1: Type 1 projects are the simplest form of the TNP projects. The single company is working in a single remote site. Only one boundary is separating the head office and the site. If the distance between the site and the head office is short, there should not be any extra travelling costs and the project is a normal short distance project. (Figure 4) (Cleland & Ireland 2007)

Type 2: Type 2 projects are more complex than the Type 1 projects, because multiple remote sites are involved. The biggest difference to type 1 is that more than one remote site exists. The sites can locate in the same country or in an entirely different country. (Figure 4) (Cleland & Ireland 2007)

	Single Company	Multiple Companies
Single Remote Site	Type 1	Type 3
Multiple Remote Sites	Type 2	Type 4

Figure 4. *Project topology* (Cleland & Ireland 2007)

Type 3: The difference to Type 1 and 2 projects is that there are multiple companies at the site. The growing amount of the companies increases the complexity level of the project. This makes the work of the head office more important, because its main responsibility is to direct the work of the multiple companies at the site. The responsibilities between the companies are usually defined in the consortium contract. (Figure 4) (Cleland & Ireland 2007)

Type 4: These types of projects are usually the most complex, because multiple companies are working at multiple sites. This arrangement requires high project management skills because the scope of the project is massive and complicated. (Figure 4) (Cleland & Ireland 2007)

The Company executes Type 1 and 4 projects. At some sites, lots of external companies are involved with the work and this causes difficulties with the software interfaces and with the corporate rules. The example of a typical software challenge is that the companies working at the site do not have access to the mutual network locations because of the restrictions of different computing departments. Different corporate rules cause lots of inconveniencies, because all the contradictory issues need to be agreed in the consortium contract. Normally the employees working at the site are employed by the parent company and this helps the daily working procedures at the site since it is not necessary to agree on separate specific consortium rules.

2.3 Global project management

> "*There is nothing permanent except change" – Heraclitus, Greek philosopher, 513 B.C*

Heraclitus compresses the key of the project management in the sentence above. There would be no need for continuously adjusting project management if there were no variance and occasional changes in the project execution process. Typically, project managers believe that the projects are delivered on time with agreed budget and according to a specified performance. These three objectives (time, performance and money) are usually the main parameters of the project. (Lock 2007)

Figure 5. *The management process* (Cleland & Ireland 2006)

Figure 5 presents main functions of the project manager. The first function is to ensure that the project is correctly planned. The right people from the organization are included to the team, so that all the agreed parameters can be executed in time with good quality. Also, the motivation of the project team is important, because challenges always appear during the execution process and sometimes it is important to find quick solutions to fix the problem. One of the project manager's most important duties is to direct the project towards the common goal and control who is responsible of what and when. One mission of the project is to provide good quality products fitting the appointed standards. That

been said, the project manager monitors, evaluates and controls the efficiency and effectiveness of the contribution of the project organization. (Cleland & Ireland 2006)

2.3.1 Global project leadership

> "Leadership is the art of getting someone else to do something you want done because he wants to do it." – Dwight D. Eisenhower, President of the United States

What separates the quote of Eisenhower from describing a dictator is the word "want". A successful leader makes people want to do things, not to simply do things because they are assigned to. There is a significant difference between these two cases. A motivated employee will keep working on the goal independently when left alone while an employee simply following the orders of a dictator may stop working when the leader is not present. In global projects this kind of motivation is important, because teams work in different locations and the project manager cannot always be present (Lewis 2007)

Globalization has caused the projects and project teams to spread around the world. The development of technology has made the communication, arranging of meetings and travelling easier than for example twenty years ago. Globalization has also changed the project management, because it is totally different to lead a team inside one office than a team with members located in different countries. The global project leadership has faced some challenges which are listed below:

Number of remote sites: Long distance between team members is a significant challenge of building relationships if there are no chances for face to face meetings. Building trust is more difficult if the contact, meetings and team events between the different global parties are missing. Project manager's task is to create ways of communication between the different locations. (Binder 2008)

Amount of different organizations: If there are lots of different locations, there might be a possibility that the knowledge is hidden inside the structure of the organizations. Also, there is a risk of harmful competition between different organizations. These kinds of issues can damage the whole project. It is a project manager's job to keep their mind open for new innovations and thoughts and to combine ideas from different organizations to become one great idea. (Binder 2008)

Cultures from different countries: People from different cultures have different kind of legacy, motivation, ethics and way of thinking. It is dangerous for the global project if the different cultures cross paths too aggressively. Good project managers must take all these issues into account and deeply understand cultural dimensions to be able to build a highly motivated and inspired team. (Binder 2008)

Different languages: Different nationalities in the project team can cause problems if the team members do not have a common language for communications. A good project

manager ensures that different parties understand each other and is ready to arrange translators if needed. (Binder 2008)

Time zones: Different time zones can be challenging for the project if the team members have different understanding of time or do not express the intended time zone clearly. This could cause problems in scheduling, meetings and communication. It may cause difficulties for the relationships of the team and frustration for the project manager. Different time zones can cause asynchronous communication between the team members and start the circle of ignorance. It is a project manager's job to arrange common project meetings and travel to meet the different members from the different countries. (Binder 2008)

One of the project manager's challenging problems is to develop commitment inside a project team. When developing commitment, the key is to find the best motivated people for the job that are also available for the project. Missing motivation can decrease the commitment level of the team. In his book Fundamentals of Project Management, Lewis (2007) represents five rules of the development of the commitment of the team:

1. "Have team members interact frequently so that they gain a sense of being a team."
2. "Be sure that individual needs are being met through participation in the team."
3. "Let all members know why the project is important. People do not like working on a loser."
4. "Make sure all members share the goals of the team. One bad apple can spoil the barrel."
5. "Keep competition within the team to a minimum. Competition and cooperation are opposites. Let members compete with people outside the team, not within it."

Lewis' rules have lots in common with the challenges Binder listed above. The first rule combines Binder's hypothesis that long distance and lacking communication can harm relationship building of the team. It is important to have co-located team meetings in virtual reality or face to face, so that the commitment level and relationships of the team can be kept satisfactory. Long distance can also cause competition between the global teams. In the worst case that can ruin the whole project. Binder presents that the competition between the global project teams can be harmful for the project. Lewis also expresses that the commitment is tough to achieve if there is a competition within the team. Project Manager's task is to change the competition to cooperation. (C&I 2006, Lewis 2007 and Binder 2008)

2.3.2 Multinational Environment

Today's changing environment and complex business world pushes project teams to be faster and more complex and to inventively and rapidly work towards their goals. The

team and commitment building demand good leadership skills from the project manager and deep understanding of different organizations, interfaces, power and motivational factors. The project management process is crucial to the project execution process, when the project involves stakeholders such as suppliers from different countries, cultures, policies, regulations and political climate. (Nurick & Thamhain 2006)

Figure 6. *Business subsystems need to be integrated to the global project team (Nurick & Thamhain 2006)*

Figure 6 presents the importance of five subsystems, which are people, process, work, tools and organizational culture. These subsystems connect diffused project teams together and build up the commitment. Without these subsystems, the project team is not individual and does not face the situational leadership. The evolvement of technology and more complex delivery scopes cause the growth of the projects and forces joint-venturing and broad talent search. These kinds of projects are usually produced in global teams. Typically, these kinds of projects can be research and development (R&D) projects and high technology projects like avionics, marine and electronics. Project manager of these project types will have to be up-to-date on things such as degree of technology difficulties, evolving solutions, complex decision process and to intricate technology networks.

In global teams, when developing specific tools for each team, risks exist. This kind of situation can drive the whole team to the situation that the tools will not communicate together and some tasks will be done multiple times. It is the management's job to define same kind of tools for the team which support the execution phase. One task of the management is to develop tools that support the idea of the diversity of a global team. Tools for this kind of work could be integrated to product development, stakeholder mapping,

concurrent engineering and spiral planning. The challenge is to integrate the working culture to these tools. (Nurick & Thamhain 2006)

2.4 Creating effective project team

To achieve goals, the project manager must recruit an effective and motivated project team. In global projects, some issues which are listed in paragraph 2.3.1 have to be thought through before the recruit work can be started. Structure of the organization, roles of the project team and the responsibilities must be agreed on before the execution of the work can be started.

2.4.1 Project driven organization

PMI divides the project organization teams in two categories depending on how dedicated the organization is. In a dedicated project team the members are assigned to work with the project full-time. The project team may be located in the same country or be virtual. The project team reports directly to the project manager and the job description of the project manager is more like line manager's because in dedicated projects, the project manager is responsible for the team members. Dedicated project teams are often seen as permanent project organizations. The project manager has independence and authority to make decisions. (Project Management Institute 2013)

In other cases, the projects commit temporary additional work input. In these projects, the project team works part-time and the team members keep working in their normal organizations. Usually project team members are assigned to more than one project at a time. Part-time teams are common in matrix and functional organizations. Also, part-time teams are used when the effort of the team member is not continuous and it is possible to work in many projects. (Project Management Institute 2013)

In the 21st century the matrix organization has become more popular. The matrix organization makes the project team working more effective and efficient. Figure 7 presents the typical structure of a matrix organization. The hexagon symbol represents the internal interface of the project. Matrix organizational design provides a possibility to use alternative horizontal organizational designs which differ from traditional organization structures that favour functional lines. Basically, the matrix organization builds the enterprise around the key activities rather than building the enterprise around the functions or departments. Also, the corporation must organize the emerging projects and organizational processes like management, inventory and information management. The project manager is appointed to lead the project and the whole project organization can change during the execution process. (Artto et al. 2006; Lewis 2007; Binder 2008; Project Management Institute 2013)

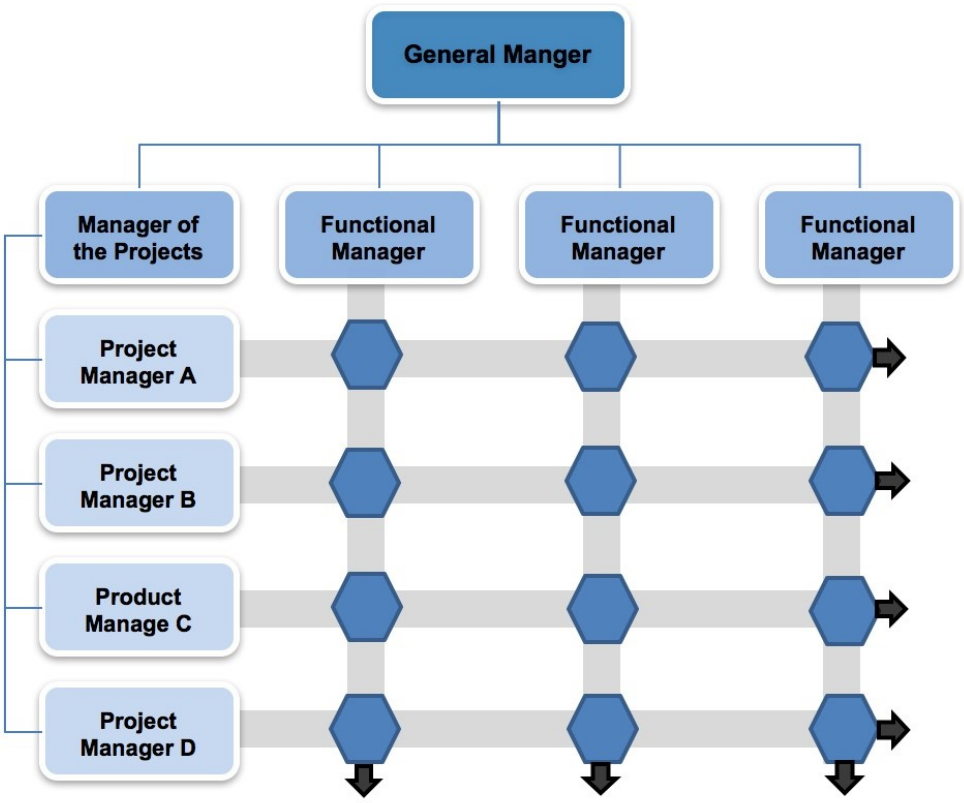

Figure 7. *Matrix organization structure.* (Cleland & Ireland 2006)

In a matrix organization, the best team needs to be built for the project and the best team members from different functions need to be selected. It is important to announce people who have enough knowledge and skills to survive through the project. For example, when searching for the best worker for the team, functional managers must understand what the complexity level of the delivery scope is and how difficult the customer is. In addition, it is important to build a team where the team spirit and the commitment are in a good level. (Cleland & Ireland 2006)

When the project organization is combined from the matrix organization the organizational structure of the project is usually easier to define than functional organization. It is easier for the customers to see the hierarchy of the project from the functional organization chart. Figure 8 presents a typical project organizational structure. There are two project managers in the project and both of them have their own organizations. The communication with the customer belongs to the duties of the project manager with a higher position. Also, the higher project manager handles reporting to The Company management and the steering committee. (Lock 2007)

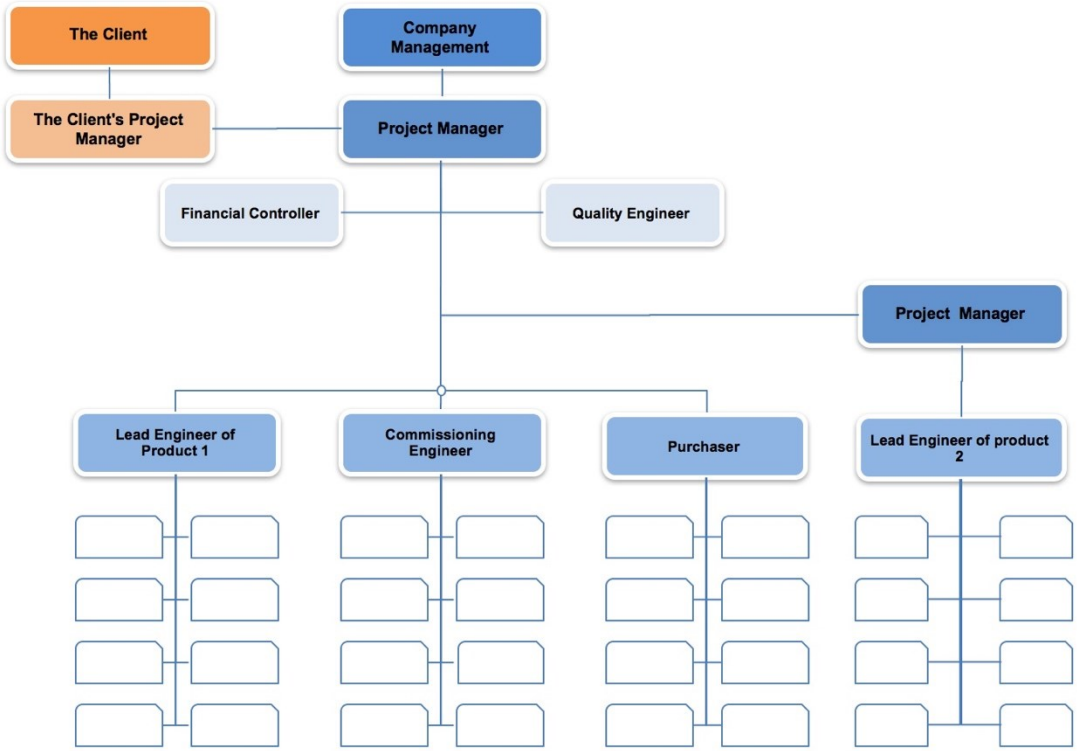

Figure 8. *Typical project organizational structure*

2.4.2 Key people in the organization

The project team includes the project manager whose main task is to lead the whole project. Sometimes there can be other project managers for the sub products, if the whole project is too complex to be led by one person. The project team includes also other project team members. Their abilities, knowledge or specific skills assist the project execution process, but they are not necessarily involved in the management of the project. (Project Management Institute 2013)

Project team typically includes positions listed below:

Project management employees' (in the Figure 8 Project Managers) duty is to lead the project team and to handle the reporting, budgeting and scheduling and to control customer and supplier communications, risk management and administrative support. The project manager is the most important person of the organization structure. The project manager's position is in the middle of everything. He/she must take care of the needs of the customer, report everything necessary to the management level, handle communication between the project team and the suppliers and keep needs of the project team in control. (Project Management Institute 2013)

Project employees' (in the Figure 8 lead engineers, commissioning engineers and purchasers) role is to support and execute tasks that assist the execution process and project deliverables. Project employees can be categorized for example in sub project managers who directly report to the project manager of the whole project, lead engineers, commissioning engineers and purchasers (figure 8). The common responsibility for the project employees is to know that they are part of the same project team and they can do tasks that help finish the project. (Project Management Institute 2013)

Supporting experts' (in the Figure 8 quality engineer and financial controller) duty is to help the project team if there is a need for supporting experts to handle tasks which need specific know-how. The need for supporting experts depends on the complexity level of the project and the knowledge level of the project team. Supporting experts are usually financial controllers and logistic coordinators. The main task of the supporting experts is to help the project team achieve the goal. In the Figure 8 there are two kinds of supporting experts. The financial controller's task is to observe and keep the project financially on track. The quality engineer's job is to handle all the quality issues and observe that all the contractual quality standards happen. (Artto et al. 2006; Lewis 2007; Project Management Institute 2013)

User or Customer representatives' (in the Figure 8 project manager) task is to ensure that the products are matching the contract. (Project Management Institute 2013)

Sellers, also called vendors, suppliers or contractors are external companies that sell the products to the project. Sellers are contractually bounded to provide products or services that match the main contract. (Project Management Institute 2013)

Business partners are also external companies that provide special services to the project. The special services can be certification, training, customization or support. (Project Management Institute 2013)

2.4.3 Accomplished project team

Usually, the project manager is the most distinguished technical person from The Company. This has been proven to be false because if the most talented person will get frustrated to leading the project team, the whole project organization can lose the management effort which the project manager could direct to the specific problems of the project. If the project manager cannot be the most talented person, what kind of features might he have?

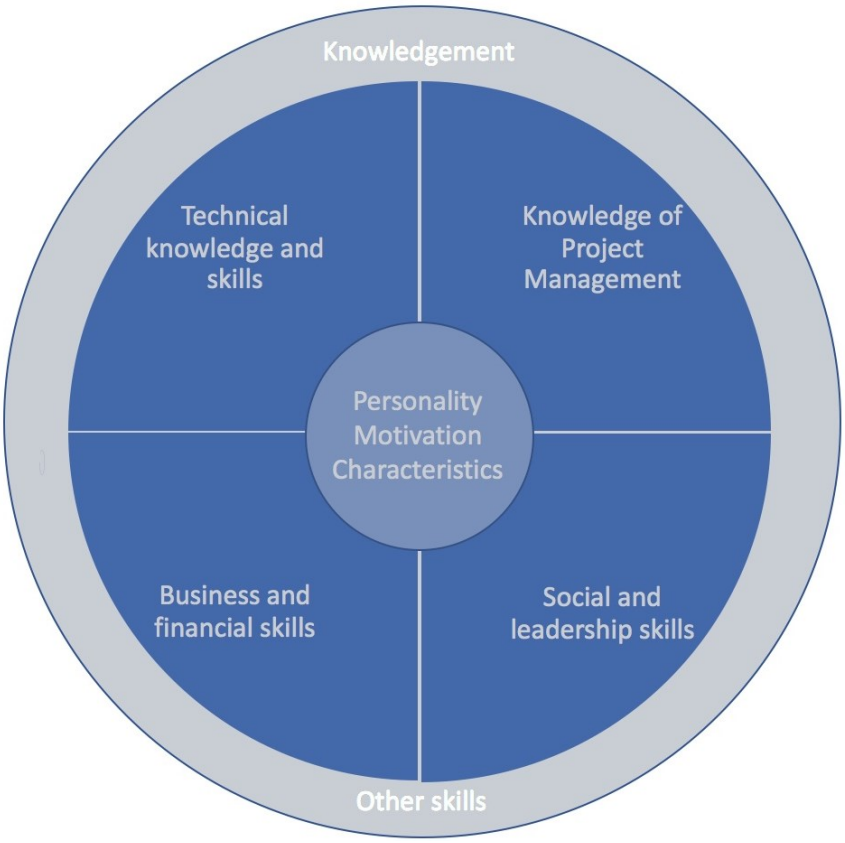

Figure 9. *Project manager's knowledge requirements* (Artto et al. 2006)

Figure 9 presents the important knowledge requirements for the project manager. A project manager should have technical and management knowledge, social leadership skills, business and financial skills and personality. Project manager's position combines management and leadership skills. That means that the project manager must lead things (management) and people (leadership). Personality, motivation and characteristics are the core things that the project management skills will be based on. One project manager can lead the project successfully with fear and tight authority, so the team will obey everything which is ordered. Other project manager can reach the same results with gentle but firm manners. (Artto et al. 2006; Lewis 2007; Lock 2007; Project Management Institute 2013)

Technical knowledge is a needed skill because the project manager has to understand the technical features of a project or process to be able to discuss the technical issues with the

customer. Problem solving is also easier if the project manager's technical knowledge is good. One important skill is to improve knowledge of the technology development and to understand the effect of new innovations to the project. (Project Management Institute 2013)

Business skills and understanding are also important because different business segments have different kind of procedures. Understanding the financial effects of project widely gives a good base to understand the big picture, not just the numbers and costs. Also, it is essential to understand the business of the customer. Understanding that different customers have different kinds of needs can help the execution process because treating the customer in a unique way the project manager can get easier acceptance from the customer. Customers notice when they are getting individual service and appreciate it. This raises the quality of relationship building. (Artto et al. 2006; Lewis 2007; Project Management Institute 2013)

Social and leadership skills can be allocated for example to social skills, communication skills and negotiation skills and problem solving. These features motivate the project team to work harder and achieve the goal, inform and lead the project team and show the right way and good example. Good communication skills are mandatory for the successful execution work because during project work, changes always appear from the customer side or from the engineering side or the changes have to be reported to the management level. The most important thing in the communication is that the sender and the consignee understand the message the same way. Negotiation skills are also important because usually project managers have to negotiate for example in additional sales meetings and conflicts. These skills are very respectable in the project business because they may make huge savings. (Artto et al. 2006; Lewis 2007; Project Management Institute 2013)

One more feature in project management is time. It is quite impossible to execute a project if there is no time to do that. It is quite a common problem that the amount of the project work is high. This means that there is not enough time to handle all the mandatory tasks. An excessive work load can also cause burn out and, in the worst case, this could mean a long sickness leave for the project manager. (Artto et al. 2006)

2.4.4 Project team communication in projects

PMI defines project communication management as shown below:

"*Project communication Management includes the processes that are required to ensure timely and appropriate, planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information.*" (Project Management Institute 2013)

To reach all the processes which are listed above, a good communication plan to help the execution of the process is needed. In a global team the communication is quite a big problem because some team members are located in different countries. Figure 10 identifies one kind of network structure of a global project team. In global teams a good communication plan is more mandatory than in national projects because the wide spread teams have to have a common strategy to communicate. In most project types the most important communication plan categories are:

- Project Management – The plan which contains main information about project definition. This plan helps project execution and controlling department.
- Project Status – Contains statistics like costs, schedules, budget plans, quality level and customer satisfaction level. This must be made by the planner or the project manager.
- Project Record – These records inform the project team of different kinds of risks and changes. The project record includes all the elements which affect the performance of the project like issues, risks and possible changes. (Binder 2008)

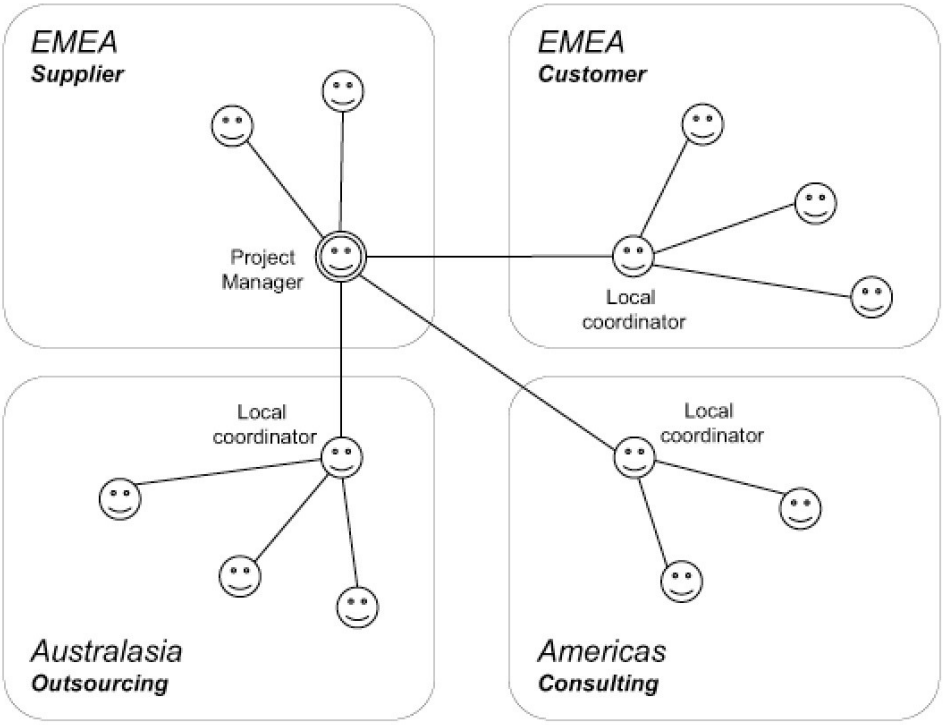

Figure 10. *Structure of the global project team (Binder 2008)*

2.5 Final phases of the project execution

The most common way to end a huge successful global project is completed by inclusion, integration or extinction. The ending process is not the easiest part, because it has to be ensured that all the contractual items are completed and there are no open claims. These open items may cause time over runs, cost over runs, tarnish the image of the project team, use extra human resources, if the accomplishment needs additional travelling and

working hours and also increase the stress level of the project team. (Transferring projects to their final users: The effect of planning and preparations for commissioning on project success; De 2001)

2.5.1 Commissioning phase

Idea of the commissioning phase is to finalize the product. The finalization means testing, troubleshooting and installing according the requirements of the customer. The commissioning is the last phase before delivery of the product. Usually the commissioning is located to the site. This means that the finalization of the product is happening under customer's supervision. This gives good opportunity to control the quality and the claims. (Kirsilä et al. 2007; Cleland & Ireland 2006; Binder 2008)

The structure of the project deliveries has changed, because customers are asking for more complete systems than standalone products. This has increased the need of the system integrator, because the systems contain many different interfaces to be connected. The phase where the equipment is delivered to the customer for final testing and it will be integrated to the main project is called the commissioning phase. In system deliveries where the systems consist of sub products and the complexity level is high, the commissioning phase is more important than in the standalone product deliveries, because usually the commissioning phase is the first moment when it is possible to test the whole system at the same time. (Kirsilä et al. 2007; Cleland & Ireland 2006; Binder 2008)

The literature treats the commissioning very lightly and focuses on identifying if the commissioning is an important part of the project or not. On the other hand, many authors and project managers have agreed that the commissioning and the installation phase are critical for the project. Lawry and Pons write in their article Integrative Approach to the Plant Commissioning Process that one of the reasons for the underappreciation is that the valuation is hard to quantify, because the structure is complex. (Kirsilä et al. 2007; Lawry & Pons 2013)

In the literature, commissioning strategies can be categorized in three different groups. The ad hoc commissioning is an action oriented and problem-solving way to execute the commissioning. The problem-solving way is not the fastest way to work because usually the problem solving takes time and effort. The second category is templates. It means that templates or checklists are used to be sure that everything worked as planned. The third category in literature is methodological. It involves analysis regarding the situational needs and selects the most relevant possible methods. (Kirsilä et al. 2007; Lawry & Pons 2013)

The processes of the commissioning can be classified in three different types regarding the downtime of the commissioning. The direct commissioning is the classical way to

handle the commissioning process. The old process must be turned off during the commissioning. Direct commissioning is one of the straightforward types and simulation or additional parallel working is not needed. This is the most popular way in the newbuilding segment. Advanced commissioning is popular in plant projects or in retrofit projects. The subsystem is possible to get isolated from the main process and it can be commissioned without stopping the main process. The advanced commissioning needs high knowledge of the system and simulations for the process. Parallel commissioning is a method where the new unit can be tested under full operations conditions. This requires redundancy between the new and the old system. The parallel commissioning would be perfect for retrofit projects, but it will need more simulation knowledge, because there is no place for the interruptions. (Lawry & Pons 2013)

The commissioning phase has become more important when the complexity level of the systems has increased because of the development of the technology. Kirsilä, Hellström and Wikström's study interviews present that more specific coordination and planning are needed for making the commissioning process clearer and more efficient. When the number of parties is increased, the complexity level of the commissioning is changed and the project manager is not able to participate in the global projects commissioning, the commissioning manager or site manager is needed. The goal of ramping up the site management is to reduce process downtime without jeopardizing the reliability of the project. (Kirsilä et al. 2007; Cleland & Ireland 2006; Binder 2008; Lawry & Pons 2013)

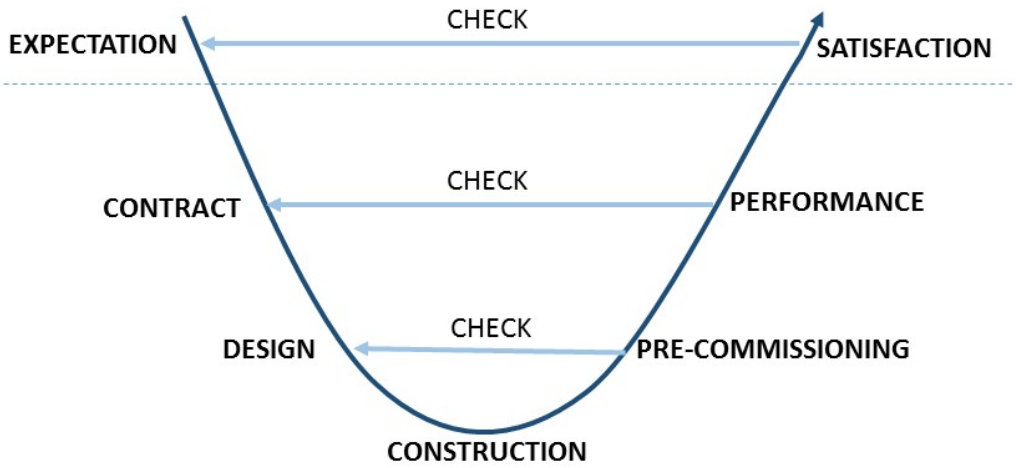

Figure 11. *Customer oriented commissioning's V-model (Kirsilä et al. 2007)*

During the commissioning phase co-working with the customer is usual. The customer has needs and requirements which usually differ from what is defined in the contract. Figure 11 presents the V-model of the commissioning. It shows which elements are related. Satisfaction is strongly related to the expectations of the customer - when the expectations of the customer are filled, the customer is satisfied. The performance is related

to the contract, because the contract rules which things are involved in the commissioning. The more different suppliers and interfaces there are, the more co-work and planning the commissioning will need. The success of the pre-commissioning depends on the design period. The better the things are designed the easier the commissioning work will be. Commissioning of well-planned projects is easier to execute, because the commissioning process is not like problem solving - most of the possible issues are already solved with simulations. (Kirsilä et al. 2007)

Customer satisfaction is in a huge role during the commissioning phase and sometimes it may help the customer to make the decision of making new contracts. The commissioning phase contains two kind of integrations: technical and social integration. The technical integration means the integration between all the technical requirements. The social integration ensures the fluent communication between the supplier and customer and keeps the customer satisfied. (Kirsilä et al. 2007; Cleland & Ireland 2006; Binder 2008)

2.5.2 Termination phase

All projects have an end. They might end naturally or suddenly if the conditions changed during the execution. These kinds of issues could be running out of funding and corporate acquisitions. Also, appearance of too high technical requirements which cannot be fulfilled can cause premature ending of the project. Ending the project is not just handing over the project to the customer. Customers and the project team have to find a consensus together. Project teams have to finish all the open claims and the customer needs to understand to finish making demands at some point. (Kettunen Sami 2009; Cleland & Ireland 2006)

Commissioning is the last phase of the commissioning. It is not possible to deliver the project before the commissioning is finished. The commissioning enables the delivery of the project, but the quickest project delivery is not always the best if there are lots of open claims. For example, in huge factory building projects the closure phase can take over 10 years and cause lots of extra work. In some projects, a termination manager, whose task is to ensure that the project is fully delivered and all the open items are closed, is hired. Tasks of the termination manager are releasing the project team to the new challenges and acting as a contact point for the customer with the open claims of the project. Termination manager is needed if the size of the project is big and there are plenty of open claims that are not preventing the delivery of the project.

The tasks of the termination manager could be:

- Ensure that all the deliveries are provided to the customer.
- Check that all contractual requirements are fulfilled and confirm with the customer all requirements which are not executed in a satisfactory way.
- Make the project execution plan with the project team.

- Maintain the surveillance of the open tasks.
- Ensure that the project is well documented and the lesson learned analysis is done, so that it is easier for the project teams or service teams to work with the project in the future.
- Close all the financial matters of the projects. (De 2001; Cleland & Ireland 2006; Binder 2008)

After the project team has ended the project and the project is transferred to the warranty team or termination manager the final meeting is needed. In the final meeting, it is important to look through the lessons learned, financial structures and check that the internal documentation is clear for the later use. Clear and specific documentation will help the work of the warranty and service teams, because they will use the documentation for problem solving. (Kettunen 2009; Cleland & Ireland 2006)

2.6 Theoretical synthesis

Theoretic part of the thesis contains theory of the project management, because commissioning and site management are not popular topics in the literature. However, there are many similarities between project management and site management.

- There is a specific process, schedule, budget and organization for the commissioning.
- In the big companies the site team is often multicultural.
- The site team is often temporary because the projects are unique.
- Communication and reporting are the main responsibilities of the site manager. At the site the site manager is the first contact of the customer and the only link between the site and the office.

Figure 5 describes the main functions of the site manager. The commissioning schedule and manning plan need to be done before the start of the commissioning. Organizing the manning to the schedule makes savings when there is no unnecessary work force. Motivating and directing the site leads to better results and better quality. Directing, controlling and prioritizing the tasks helps keep the commissioning on time.

Figure 9 presents the knowledge requirements of a project managers. The same key requirements are essential for site managers as well, with minor differences. There are some differences. Site manager does not need so strong financial or contractual skills, but financial and contractual understanding supports the work of project manager. Technical knowledge is important for site manager because the main task is to commission a technical solution. The technical knowhow is one of the key requirements.

The next chapter describes the type of the project management and the structure of the commissioning in The Company.

3 PROJECT MANAGEMENT AND COMMISSIONING AT THE COMPANY

Marine projects are usually unique and special, because the business requirements are strictly specified, structure of the delivery is very complex and there are many interfaces to be connected. The vessels are like cities - electricity, water, cooling and waste disposal is needed. The 21st century has changed the cruise liner business. The operators have started to compete with new luxurious facilities like water parks, surfing simulators and different kind of restaurants which attract new customers. Another big trend is to develop the system's efficiency by decreasing consumption, developing waste disposal and developing systems to support sustainable development.

3.1 Marine projects

The Company has long experience of the marine business. They have executed important projects and patented multiple innovations, which guarantee the technical advantage in the niche market. Their core business is in newbuilding projects but they are focusing on the service business too. The basic structure of a marine project is quite similar and can be generalized to modern newbuilding project (Figure 1).

The Company executes different kind of projects. Therefore, it is important to categorize the projects so it is easier to recognize which are the most affected projects regarding the project execution. The level of the class category has direct impact on the price of the contract, number of the subsystems and amount of the commissioning engineers. Different project classes can be found in Table 1.

Class 1 is the simplest project scope and it consists of only one subsystem. These kinds of project scopes are not the most common ones, but sometimes these kinds of contracts are signed. During the commissioning phase the normal number of the commissioning engineers is from two to three and there is no need for site management function.

Table 1. *Complexity level table*

Class	Explanation	Complexity level
Class 1	The easiest project scope – One simple sub system	1
Class 2	Easy project scope – One complex sub system	2
Class 3	Easy project scope – Two sub systems	3
Class 4	Average project scope – One complex sub system	4
Class 5	Average project scope – Two sub systems	5
Class 6	Hard project scope – Two to three sub systems	6

Class 2 presents higher complexity level than class 1. There is also one subsystem integrated to class 2 project types, but the subsystem contains more equipment than the class 1 subsystem making it more complex. The number of interfaces is quite big and that increases the complexity level. In the markets, there are many companies which offer class 2 subsystems. This increases the competition of the business segment and reduces the gross profit opportunities of the projects. Currently in class 2 projects there is no need for site manager or the site manager works part time. Typical number of the commissioning engineers is three engineers per commissioning.

Class 3 projects contain two subsystems and the complexity level is higher than in the previous ones. The number of the internal interfaces increases and that causes increasing of the amount of the workers in the project organization. Class 3 project types fill the needs of the specific customer segments and they are quite important for The Company. Class 3 commissioning is complex and normally there are from four to seven commissioning engineers handling the big scope. The site management is handled part time or full time depending on the project.

Class 4 project contains only one subsystem, but the complexity level of the sub system is the highest. The number of the interfaces to the vessel's other equipment is high and many different types of engineers to execute the commissioning of the vessel are needed. The site management is part time or full time.

Class 5 products are the most common delivery scopes that The Company provides. The number of the subsystems is two but those are so important and complex that more engineers than in the other classes are needed. That is why the number of the commissioning

engineers is from six to ten. The site management is handled part time or full time depending on the project type.

The most complex delivery scope is class 6. It contains more than two subsystems and sometimes some R&D solutions. These kinds of projects are executed rarely but to be able to answer the needs of developing markets they are necessary regardless of the high costs and the challenging scope of the work. The project of this type contains from eight to fifteen commissioning engineers and site management is part time or full time.

3.1.1 Project organization

The Company's project organization, as the appendix A shows, can be divided to different categories: project management employees, project employees and supporting experts. The project management employees consist of project manager who has the full responsibility of the project and the project managers of the sub systems. The sub systems are like group of interconnected and interactive products that perform an important job as a component of a larger system. The project employees comprise lead engineers and engineers of sub systems. There are also supporting experts like purchasers, financial controllers, quality and documentation engineer.

Appendix A presents that the key person of the project is the project manager. The project manager focuses on realizing profit, keeping the contractual delivery schedule and high customer satisfaction. The key responsibilities of the project manager are to be the first point of contact in the customer communication, verify the specification of the equipment, ensure that the scope fills the contractual specification and delivery and the installation are correctly done. The project manager leads the project until the equipment are handed over to the customer.

The project manager of the sub system (Appendix A) is in charge of only the tasks of his own sub system. The main responsibility areas of the project managers of the sub systems are project control and management duties and support.

The system is complex, so it is impossible to handle execution and technical issues by the same person (Appendix A). This is why the technical responsibility is given to the lead engineer whose main responsibility is to handle all technical issues regarding the sub systems. The key responsibilities are design verifications, technical specifications, technical responsibility of the sub system, validation of the technical scheduling and communication with the customer on technical issues. The lead engineer is responsible of all the technical issues or questions from the customer.

Sub systems contain multiple equipment and there are engineers which are professionals of their own field to reduce the work of the lead engineers. These engineers are called system engineers. The system engineers are responsible of the design of the specific

equipment. Also, their task is to be in charge of interface design and supporting lead engineer. The documentation controller is included in each project and their main task is to handle changes of the documentation and provide the documents to the customer. The commissioning team engineers differ from the normal engineers, because their work is at the site and they are in charge of the testing and the commissioning of the system.

Also, there are multiple supporting experts (Appendix A) included in the organization. The main task of the experts is to advocate the execution process. The number of the experts depends on the sub system and the complexity level of the project. Typically, the most common supporting experts are financial coordinators, quality engineers, document engineers and project assistants.

3.1.2 Project structure

The lead time of the typical marine project is from one to four years depending on the type of the vessel. The complex vessels' such as cruiser's lead time can be four years, but smaller vessels' such as tugs' lead time can be less than one year. However, the main phases of the project are still the same from start to end (Figure 1). The sales team makes the contract with the customer and hands over the project to the project team. The project team will purchase all necessary equipment from the suppliers or manufactures the equipment by themselves. After that the procurements will be officially tested and approved. After approval the equipment will be sent to the customer site by project team and the installation of the equipment is under customer's responsibility. After commissioning phase, the project will be handed over to the owner and the warranty phase of the project can start.

The Company divides the project process in three different main phases (Appendix B): project initiation, project execution and project close out. These three phases have a different kind of meaning. The project initiation means the period right after signing the contract and hand overs. Duration from the signing of the contract is approximately half a year. There are two different types of handovers in the initiation phase: the sales handover is a meeting where all the contractual and financial terms are opened and the technical hand over is the meeting where all the technical terms are explained and opened. Some potential risks are listed also. It is important that the project team and the sales team know how to read the contract and what kind of scope has to be delivered. There are two kinds of kick-off meetings (KOM). Internal kick-off meeting is an appointment where all project information is presented to the project team. The customer kick-off meeting is an appointment where the project team is presented to the customer's project team and common rules are agreed on.

Project execution phase is the longest phase of the execution process. Normally it takes from one to three years to pass this phase. During this phase, the project has its most critical phases like manufacturing and commissioning. Project execution phase starts with

engineering and manufacturing phase. Before this phase there is a design's freezing point. That means that all the design issues must be locked and the changes are not possible without extra costs. The manufacturing phase ends to the factory acceptance tests (FAT). The FAT proves that all equipment fulfils the technical and contractual requirements. Every piece of equipment is tested at the factory to avoid any issues during the commissioning phase. After FAT the equipment is ready to be dispatched to the customer. Typically, the customer handles the installation work of the equipment. The detailed commissioning phase is presented in the chapter 3.2. After the commissioning phase, there is project delivery to the end customer. In the marine business, this means that the project is handed over to the ship owner and the vessel leaves for commercial operation. It is important that all the work is done, because the price of the work will increase if the work is needed to do after the vessel is sailing.

The last part of the execution process is the project close out. The meaning of this phase is to close the project successfully and hand over the project to the warranty team. In the meeting, the idea is to list all open remarks, explain what is done and what kind of changes there have been. During the project, it is important to provide all important documents which help warranty teams' work. The warranty team's job is to handle all possible warranty claims. The meaning of the project close out meeting is to hear the project team's opinions about the execution process, list lesson learned issues and present the project's financial results.

3.2 Commissioning phase of a project

Typically, commissioning phase is defined in the contract as all-inclusive, capped or hourly based. All-inclusive commissioning means that all commissioning work is included in the contract and there are no hour-based limits. The all-inclusive commissioning is the most popular commissioning type, because of the easiness for the customer. This causes risks for The Company because of the unpredictability of the costs.

Capped commissioning means that there is a limit in man-days. The limit means that specific number of hours are included in the contract and if the commissioning takes too long there is a possibility to invoice the excess hours. The capped commissioning shares the risks for the customer and for The Company.

The hourly based commissioning means that the commissioning will be invoiced based on hours. In hourly based commissioning the risks are in customer side. The most common contract term is all-inclusive and nowadays it is causing over budgeting.

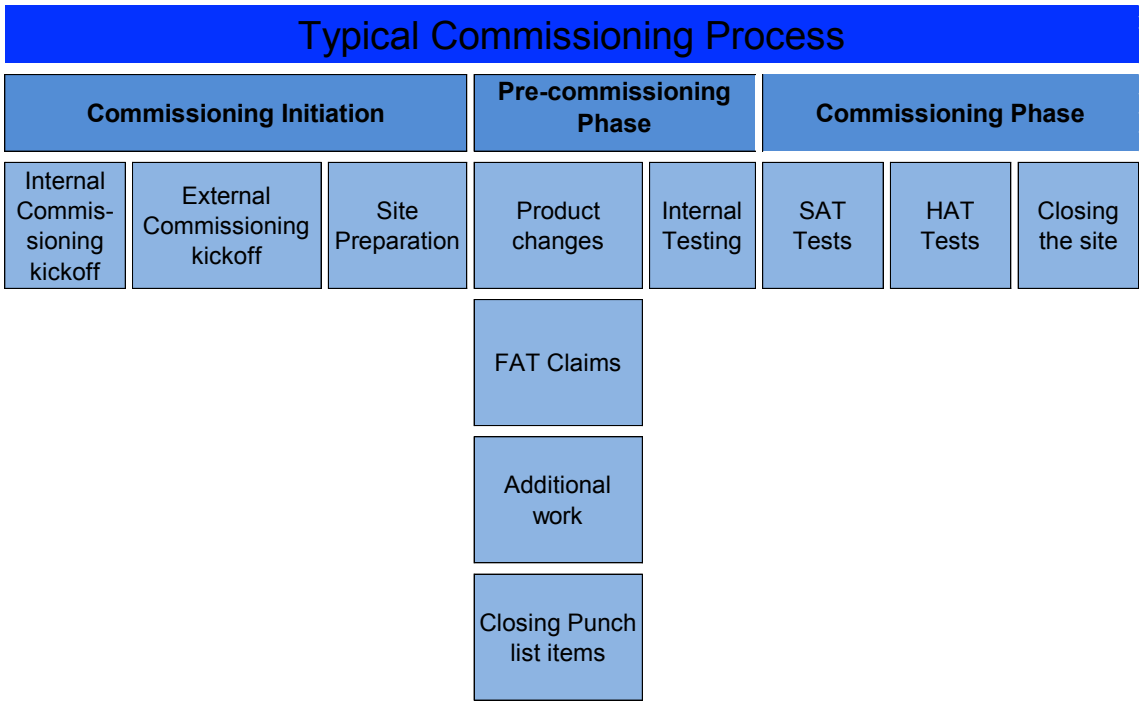

Figure 12. *Typical commissioning process chart*

Figure 12 presents that the commissioning phase is located in the end part of the execution phase. The appendix B and Figure 12 are based on the project execution process of The Company. During the commissioning phase, all the equipment needs to be tested and verify correct operational functionality according to the contract specification. It must be checked that the system works as planned and the different interfaces are connected and the system fills the classification society's regulations. The commissioning phase contains different phases: planning and scheduling, internal and external kick-offs, pre-commissioning and commissioning phases. The commissioning phase starts with planning period. The shipyard gives a preliminary schedule of the commissioning to The Company. There are some key milestones in the schedule like Harbour Acceptance Tests (HAT) period and Sea trial Acceptance Test (SAT). The commissioning launch of the project is calculated according to the milestones received from the customer. The scheduling is necessary because if the commissioning engineers are sent to work too early, the commissioning costs will raise rapidly. If the engineers are sent too late, the overtime and weekend allowances will cause extra commissioning costs or in the worst case the whole vessel will be delivered late.

After the planning phase, there are internal and external commissioning kick-off meetings. The internal commissioning kick-off meeting is a meeting where the project manager and the lead engineer present the technical scope to the commissioning engineers. Working times and travelling rules need to be agreed on so that the budget planning is more accurate and all the workers are treated equally. The contractual terms regarding the commissioning are needed to be clarified so that all the workers know which tasks are included in the contract. One of the tasks is to introduce the commissioning team to each

other and expound the shipyard's working methods and specification of the equipment. The Health, Safety and Environment (HSE) issues are important so that The Company can guarantee safe working environment for the workers.

The external commissioning kick-off is a meeting between The Company and the customer. In the meeting, common rules of commissioning are presented. Common rules make working more comfortable and prompter. The target of the meeting is to introduce The Company's commissioning team to the customer's team so everyone will know each other before the commissioning phase starts. The commissioning schedule needs to be discussed so that the customer knows when the commissioning of the equipment of The Company will start and what tasks must be handled before the commissioning. Also, the communication methods, networks and reporting tools need to be agreed so that both sides will know the correct persons and forms. The working times and possible national holidays in the customer's country need to be informed, so those can be considered in the schedule planning. The HSE rules must be clarified so that the workers know how to act and where to go if something unexpected happens.

The pre-commissioning is the phase where all FAT claims, product changes, internal testing and punch list items are handled. The whole system and all possible interfaces are tested and all specific claims are handled. Sometimes there are minor claims from FATs and product changes which are important need to be handled before the actual commissioning starts. During the pre-commissioning, there are equipment specific engineers at the site. This phase can take almost three months and is a critical part of the execution project. This is the first time when the system is tested and it is seen if the design works as planned.

After the pre-commissioning phase comes the commissioning phase. When the system is successfully tested internally during the pre-commissioning, it is possible to move to the commissioning phase. This means that the official tests are implemented and the system gets approval from the owner and the shipyard. Official tests are approved by a specific classification society whose duty is to work as a neutral party of the shipbuilding process. The official test proves that the system works as defined in the contract and the system fills the classification society's regulations. The commissioning phase contains two kinds of tests: HAT and SAT. The HATs are done at the dock and the single pieces of equipment are tested successfully to be sure that the vessel is ready to sail at the sea. During the SAT performance and operation of the vessel is demonstrated and approved. The SAT will prove that the vessel works as agreed. During the SAT the punch list is made and after all the claims are fixed the vessel is ready for the final delivery to the owner.

3.3 Site management in case company

The commissioning phase is a hectic period. There can be over 15 commissioning engineers at the yard at the same time. Some of them stay for a couple of days while some of

them stay for several months. The working atmosphere inside the vessel is typically even chaotic. All suppliers want to finish their tasks on time to avoid the penalties of being late. The shipyard pushes the suppliers hard and requires comprehensive reporting to ensure that everything is on schedule. The commissioning phase affects the work at the office as well. The project manager will participate in the site activities if needed, but their work load is typically too high to be at the site all the time. Other critical and urgent cases might be broken parts and unclear drawings that cause uncertainty for the commissioning team. All interruption of work will impair the worker's duties and cause troubles if all workers try to solve the issues by themselves. That is why site management is needed.

Previously the site manager's duties have been listed in The Company's commissioning report in the following way:

- Safety responsibilities: responsible that safety rules and regulations shall be fulfilled
- Keep up the scheduling and report commonly to the office
- Inform when commissioning engineers are needed at the site
- Present vessel and the shipyard for the first timers
- Manage and inform the logistic issues
- Work as head of the commissioning team and responsible of the HAT and SAT tests
- Give technical support to the customer if needed
- Handle local purchases if needed
- Report quality problems to the project manager
- Manage site office (cleaning, equipment, printer etc.)
- Manage all documentation (red pen markings etc.)
- Manage all claims
- Manage SAT arrangements
- Report directly to the customer

The duties listed above are from 2009. Now there are no tools or processes to execute tasks above. This creates differences between the sites and sometimes negative outputs are appearing, like different kind of reporting. Management is difficult to follow commissioning because common rules are missing.

The site management culture has changed in ten years. Now the size of the commissioning teams has increased. Earlier, the size was only from three to four members and nowadays the team can have over ten members. The scope is more versatile and complex. The conclusion is that the technical knowledge of the commissioning engineers has narrowed. The current commissioning engineers' knowledge is not as wide as earlier. Earlier, the commissioning engineer managed almost all subsystems at the same time but now specific specialist for each subsystem and piece of equipment are needed. When the number

of the engineers increases, it will increase commissioning costs too, because there is need for extra hotel rooms, flight tickets and salaries for example.

Normally, there are two kind of site managers: part time and full-time site manager. Commonly, there is a part time site manager handling the commissioning, because it is cheaper and the project managers have not seen a reason for full time site management. The part time site management is usually implemented in the way that one of the commissioning engineers handles site manager duties alongside their normal commissioning duties. Usually the engineer who spends the longest time at the site is named as a site manager. Part time site manager's main tasks are handling reporting between the site and the office and being the contact point at the yard.

If the commissioning is classified as challenging or the project manager wants a full-time site manager, it is possible to arrange that. The full-time site manager is usually a senior experienced commissioning engineer with high knowledge of the system. The site manager can be external or internal depending on the case. The full-time site manager's tasks are to handle all tasks which are listed above. This should improve the customer value and communication, but as the Figure 13 presents this might not always happen. The projects with a full-time site manager cause more costs than similar projects with part time site management, because one extra headcount is hired. Also, there has not been very good feedback from the customers about full time site management, because some of the site manger's knowledge is not as wide as needed. Cultural conflicts are quite common, because the customers are located around the world and the site managers live abroad day-to-day and they work under customers' supervision.

There are also lots of differences what is the contractual relationship to the firm. If the site manager is working as external worker, it will cause extra challenges, because the customer cannot see the difference between the internal and external site manager, but accesses for different software and internal networks will cause challenges, because the external site managers do not have access to the networks of The Company.

The total commissioning costs of the different projects are presented in Figure 13. The horizontal axis presents the delivery year of the vessel and the vertical axis expresses the total commissioning costs, which are collected from SAP. The total commissioning costs include the engineering, quality and travel costs from the commissioning period. This will make the results more accurate. The projects which are listed in Figure 13 have the same kind of scope and complexity level (Table 1). Also, the scope and revenue of the project are almost same. The full-time site management commissionings are marked as red circle and it seems that the site management function is not balanced, because the full-time site management commissionings are the most expensive. This proves that there are major differences in site management function.

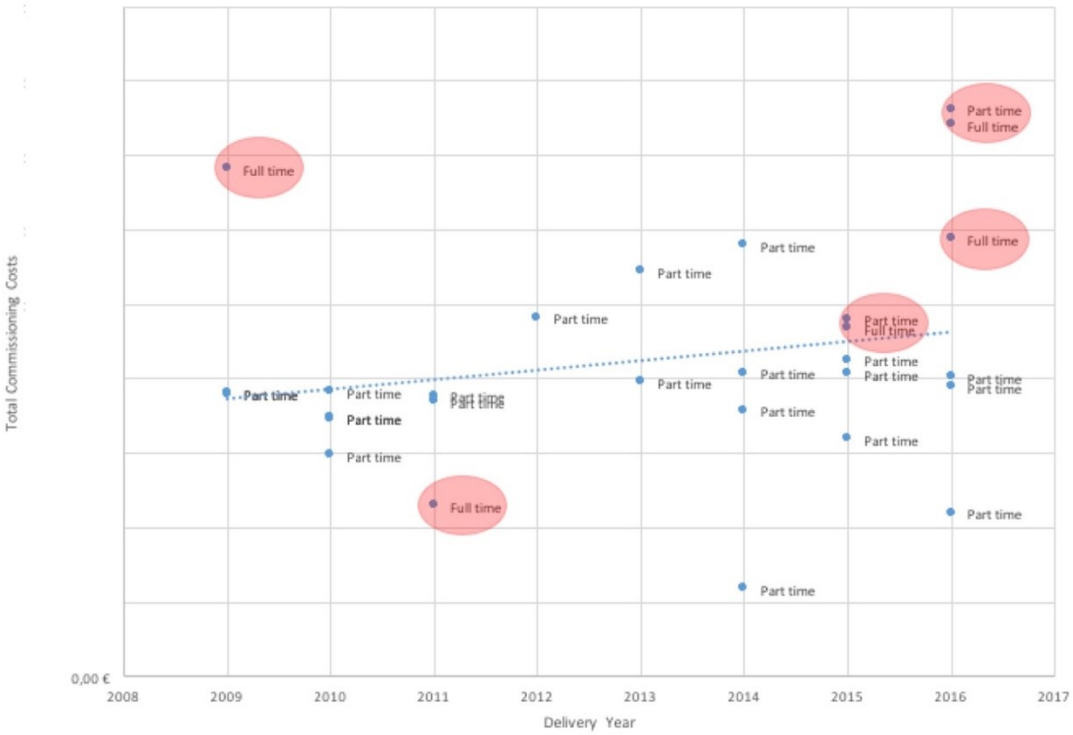

Figure 13. *Costs of different types of site management functions*

4 RECOGNIZING INSUFFICIENT COMMISSIONG TYPES

The Company has executed over 50 different type of projects during the time of the monitoring period. This chapter finds answers to the first research question: For which projects is prompt site management the most crucial? The idea is to recognize which project features cause increased costs of the commissioning phase. The target is to specify which kind of project types are included in the group at risk regarding the increased commissioning costs.

Challenges of the data collection is that some of the costs are allocated under other WBS elements which they would not necessarily belong to. For example, the travel costs of the commissioning engineers during the commissioning phase are allocated under the travel WBS element. This skews the commissioning WBS element. This has to be taken into consideration when collecting the costs of the commissioning phase.

4.1 Data collection

The data of this analysis is provided by the ERP data. The data from ERP system contains specific WBS costs data of the projects. The total commissioning costs are collected for each closed project. After that the idea was to find ways to sort the projects to the different groups to see what kind of perspectives cause the increased costs. Before starting the collection of the costs, it needs to be decided which other WBS elements cause costs for the commissioning phase. This requires specific data valuation and conversations with the co-workers. The conclusion expresses that three other WBS elements in addition to the commissioning element cause costs for the commissioning: engineering, travel and quality.

The Company has noticed that the lead engineer's engineering costs during the commissioning phase were allocated to the engineering WBS element. The engineering work during commissioning was pointed to the wrong WBS element and this skews the cost structure of the different phases. As mentioned before, the lead engineer is responsible for all technical aspects and design changes during the commissioning phase. The Company's engineering process determines that all the engineering work should be done before the freezing point. During the commissioning phase the work should contain only supporting work for the commissioning engineers. The engineering work during the commissioning will increase the costs, because the design changes which are made during the commissioning phase will rise the total costs of the project. The work at the yard is more expensive than at the factory. Also, the amount of the engineering costs during the commissioning phase could signal the quality of the engineering work.

After the additional WBS elements have been defined, the costs from the commissioning time need to be clarified. The specific costs are possible to be collected from the ERP system. The commissioning period is usually the time between the first kick-off and the delivery of the ship. The commissioning periods in on this research were found at the monthly financial reports. It was important to add one month to the end date of the commissioning, because there is a small delay in the billing. When the commissioning period and the additional WBS elements are known the total costs of the commissioning can be collected from the ERP system.

The idea of the research is to find the project types which increase the costs the most. Before answering this question, some more information of the projects needs to be studied. In this research, five additional aspects have been studied: shipyard, ship number, complexity, type of site management and type of contract.

Every customer has different ways to work and the level of knowledge of The Company's systems. The number of ships is strongly related to the costs of the commissioning. The first vessel of the series consumes the biggest amount of commissioning work. In the following vessels of the series the same inputs as in the first vessel can be used and there are no needs to use developing hours again. The complexity level (Table 1) correlates strongly to the commissioning costs. The more complex the vessel is the more commissioning costs will appear. The type of the site management also affects the final costs of the commissioning. The full-time site manager has less time to do productive work if the description of the work contains management, communicating and reporting. On the other hand, the part time site manager is one of the commissioning engineers and responsible of lots of productive work including the scope of work. Also, the contract type is related to the commissioning costs. If the contractual type is all-inclusive the customers take time to proceed with the schedule, because they know that the commissioning is included in the contract. In capped commissioning contracts the biggest problem is the invoicing. Some of the customers are not willing to pay for exceeded commissioning hours.

After all these points mentioned above are cleared the analysis table can be created for inspecting the commissioning costs of the different project types. The Appendix C presents the table where all the data will be collected from the ERP and from the external networks.

Appendix C's project, project name, commissioning time window, shipyard, project type, type of the vessel, ship number, contract type and the delivery of the vessel fields (lighter grey boxes) are collected from The Company's monthly reporting documents. The project field describes the unique code of the project. The project code also works as a search item in the ERP system. The project name describes the name of the vessel. The project type informs what kind of and how many sub systems are included in the project. The project type is also one of the components which define the complexity level of the pro-

ject. The size of the commissioning team defines how well the commissioning is executed. If the number of the participants is high compared to the other similar projects it might be a signal of the commissioning team's weak level of technical knowledge or poor resource management.

All commissioning costs, engineering costs, travel costs, quality costs and engineering costs fields (lighter blue boxes) of the Appendix C are collected from the ERP system. The as sold commissioning field informs the budget when the project was opened. The actual commissioning field describes the actual costs when the project was closed and the commissioning delta describes what was the difference between the actual and budgeted costs. The percental difference of the commissioning field shows the percental difference between the actual costs and the budget. The commissioning engineering, commissioning travel and commissioning quality fields inform how much costs these cause during the commissioning phase. The total commissioning costs defines the total costs of the commissioning are. The total commissioning costs are the real costs of the commissioning which include all the allocated costs and these can be compared. The engineering costs are collected in the same way as the commissioning costs. The as sold field informs the original budget, the actual field informs how much costs there are after the close out of the project and delta informs the difference between actual and sold costs.

4.2 Data validation

It was possible to find lot of data from the SAP, but it was challenging to filter all unreliable data out. In Appendix C all the data were collected from the projects' monthly reports and those contain reliable information. The history data was easy to access because The Company's folder network was organized well and the needed information is easy to find.

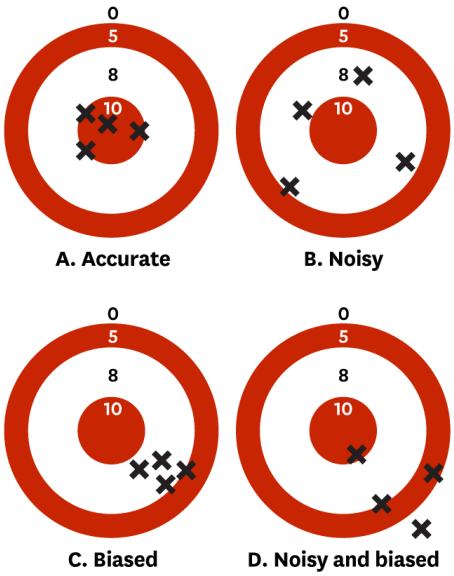

Figure 14. *Different types of accuracy (Kahnemanet al.)*

The only uncertainty factor was the validity of the dates of the commissioning period. There were problems to collect the right dates. If it was not possible to find the specific dates of the commissioning period, estimated periods were used. The estimated period was six months backwards from the delivery date of the vessel. The estimate gave valuable approximation of the commissioning period, because the current estimate for the commissioning time is six months. If the estimate goes wrong, all the related costs will be wrong. If the commissioning period is estimated wrong, the projects with commissioning period longer than six months will get advantage of collecting the additional costs from the engineering, quality and travel WBS elements.

In the analysis part, a scatter chart is used. The scatter chart helps removing errors from the data. The scatter chart, which is used in the analysis, notes the data validation problems. Figure 14 presents different kind of types of accuracy problems. The option A illustrates the required option, that all the different values are located near each other. This informs that all the same types of values are similar and the situation is balanced to the optimum point. The option A process is balanced. The option B describes the situation where all the values are spread around the bull's eye. This means that there are lot of

widely scattered hits. The process is not balanced, but it is sharp. The option B function is not balanced. The option C describes that all the values are clustered together, but they have missed the bull's eye. This biased situation means that the accuracy of the project is not balanced, but the process works, because all the values are clustered. The option D describes that the process is not balanced nor sharp, because there is no strict formula. (Kahnemanet al.)

The scatter chart and the different accuracies will help to find the projects whose commissioning periods are not correct. If most of the same kind of projects are clustered together, but there are some which are not, there will be a possibility that some of the projects have wrong commissioning periods.

4.2.1 Reliability of the SAP data

Also, the data from SAP contain some inaccuracies, which causes some errors. The commissioning costs contain some travel costs. All the commissioning engineer's travel costs are now allocated to the travel WBS element. This mispresents the total commissioning costs, because the travel costs like flight tickets and hotel costs of the commissioning team during the commissioning phase are allocated to the wrong WBS element. There have been problems with the travel policy in The Company.

There are no common rules which define how often it is legal to travel home. Extra vacations to home increase the costs a lot. Sometimes high travel costs are signals of bad scheduling of the commissioning if there is a need to send team members back and forth in a tight schedule.

The quality costs contain lots of commissioning costs. Many quality claims are made during the commissioning phase, because it is the first time when the whole project system is integrated together and tested. Now the quality costs are not observed in the commissioning costs. Also, there are no clear rules for quality policy in The Company. Some project managers claim even minor issues while some think that the same issue is contained in the commissioning. Well done quality work signals how much the project has received claim credits from the suppliers.

4.3 Recognizing and analysing insufficient commissionings

The analysis is executed by using spreadsheet software's scatter charts, because those present the status of the specific projects well. When using the scatter chart, it is possible to find out if the commissioning process is causing major costs, what kind of project types are the most insufficient ones and compare costs of different project. The main idea is to find which kind of additional information, like customer or complexity level etc. affect the increased commissioning costs. The charts inform if the vessel is the first vessel of the series or a repeat. All the charts have same kind of parameters and axis values so it

is possible to compare them. The trend line presents the rate of growth of the commissioning costs. Steeper trend line presents faster growth of the costs regarding different types of charts. In this thesis, the amounts are wiped out, but the same scale of the chart enables the comparing.

4.3.1 Type effects to the commissioning costs

The first analysis compares different kind of project types. The analysis aims to find if the project type affects the total commissioning costs and what kind of projects have the biggest effect on the costs. The different project types are presented in Table 1. The classes are divided to four different groups. The first two project types, class 1 and 2, have limited scope of supply. Typically, these types of projects are not executed by The Company. The class three projects have been more common in the past years. The scope of the system does not include as high technology as the higher classes. The classes four and five are most common, because they belong to the main delivery scope of The Company. Most of the class six projects are high technology or R&D projects and those are executed rarely.

Figure 15 presents the total commissioning costs of the class one and two projects from 2009 to 2016. In the horizontal axis, period from 2009 to 2017 is presented and the vertical axis presents the total commissioning costs. The chart shows that there are no series vessels and all the projects have unique technical design. Despite the specific design of each project it can be analysed that the total commissioning costs are not increased during the period. One reason to explain the slow growth of the trend line is increased standards of living and inflation. It can be reasoned that the commissioning costs of class one and two projects are under the accepted limits and there is no need to analyse these types of projects.

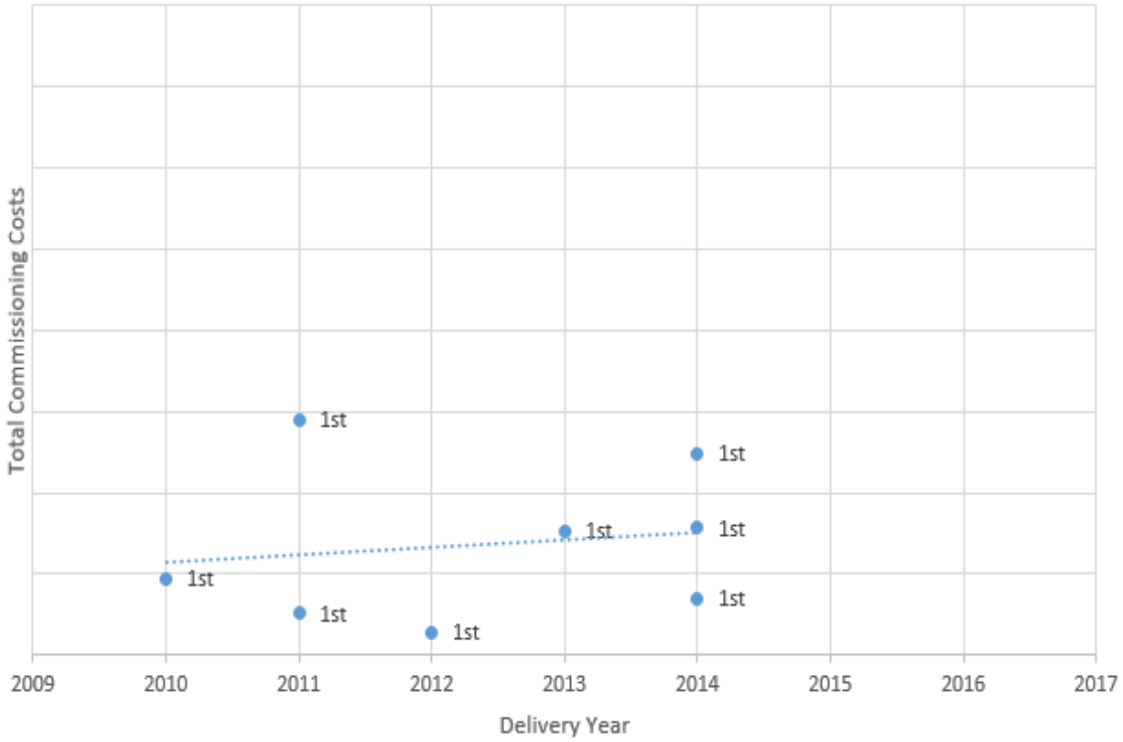

Figure 15. *Total commissioning costs of the projects of class one and two from 2009 to 2017.*

Figure 16 illustrates the total commissioning costs of the class three vessels. The main idea of the chart is the same as the chart of Figure 15. Now, it can be noticed that the commissioning costs of class three vessels are higher than those of class one or two. Also, if the project is pilot vessel or repeat one, it has an effect on total costs. The vessels series are marked as red and green in Figure 16. As the figure present, the pilot vessels are more expensive than the repeat projects. The commissioning costs are decreasing when the series is moving forward. Growth of the trend line can be explained with the differences between series. The green series' vessels are smaller and simpler than the red series vessels. That is why the commissioning costs are lower. Based on the analysis, it can be stated that class three vessels are not the most crucial ones as long as the commissioning costs are decreasing. It will be interesting to see the costs of the next series' pilot vessel.

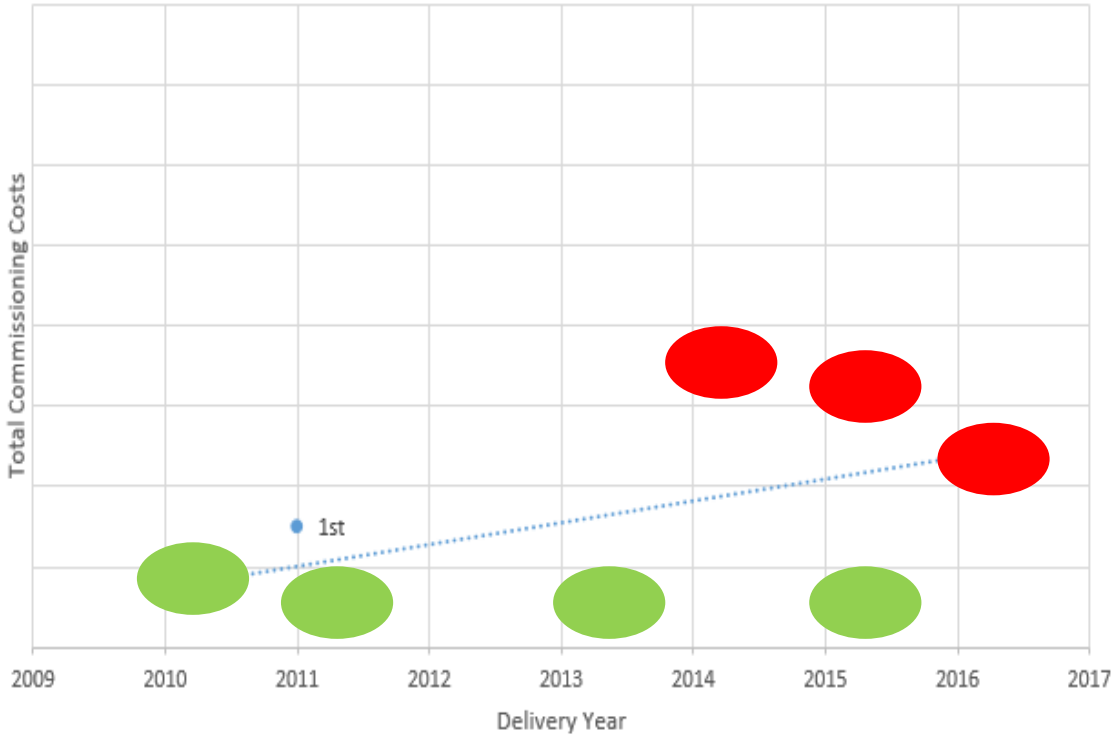

Figure 16. *Total commissioning costs of the projects of class three from 2009 to 2017.*

The most common project types of The Company are the class four and five projects. Figure 17 indicates the total commissioning costs of the class four and five project types. The scale and the axis are same as previously. The total commissioning costs in Figure 17 are higher than in the previous classes, because the technical scope is more complex. The dispersion between the same kind of projects is enormous. There is also a clear gap between the first vessels and the repeat ones. The reason for this is many design changes had to be made during the commissioning. This raises the commissioning costs of the first vessels. For the repeat vessels, it is possible to use the same design as in the first vessel. It can be seen that the total commissioning costs have increased approximately 25 % in seven years. The scope of the class four and five vessels has been the same during the period and there are no explanations for the growth of the trend line. The reasons could be the work efficiency of the customers or the increased standards of the living and inflation. Some customers can execute the commissioning period of the vessel faster and promptly. This will be investigated later.

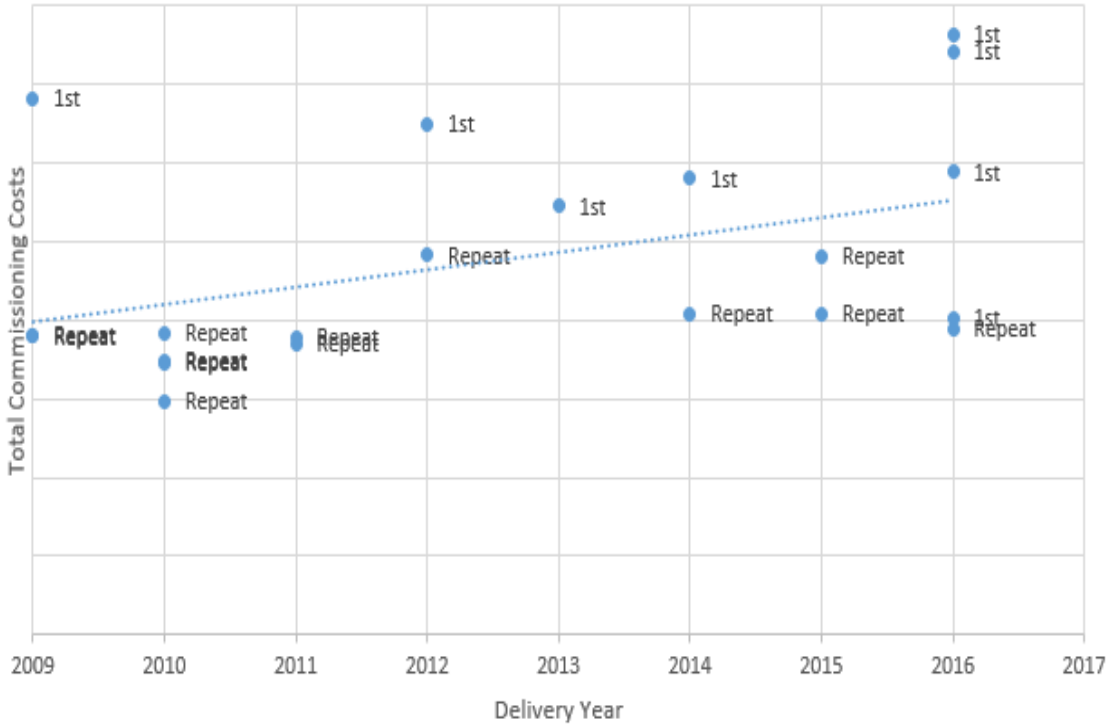

Figure 17. *Total commissioning costs of the class four and five projects from 2009 to 2017.*

Figure 18 presents the total commissioning costs of the class six projects. The scale and the axis are defined as in the previous charts, so it is possible to compare the charts. There is one issue that distorts the chart. The green marked project contains costs of two vessels. Both vessels have the same project code in the ERP system so the costs of two vessels are allocated to one project. The class six projects include high technology and some R&D solutions and typically the length of the series consists only few vessels. The total costs of commissioning are higher than the classes from one to three and higher than the average costs of the class four projects. The change in the trend line is quite enormous in a short period, but it can be defined that some of the projects have a larger scope of delivery than the others. Still, the commissioning costs of the class six are higher than average projects.

The results of the previous analysis show that the biggest issues with the total commissioning cost are in classes from four to six projects, because the dispersion of the period is biggest and the slope of the trend line is deepest. These classes need more detailed analysis.

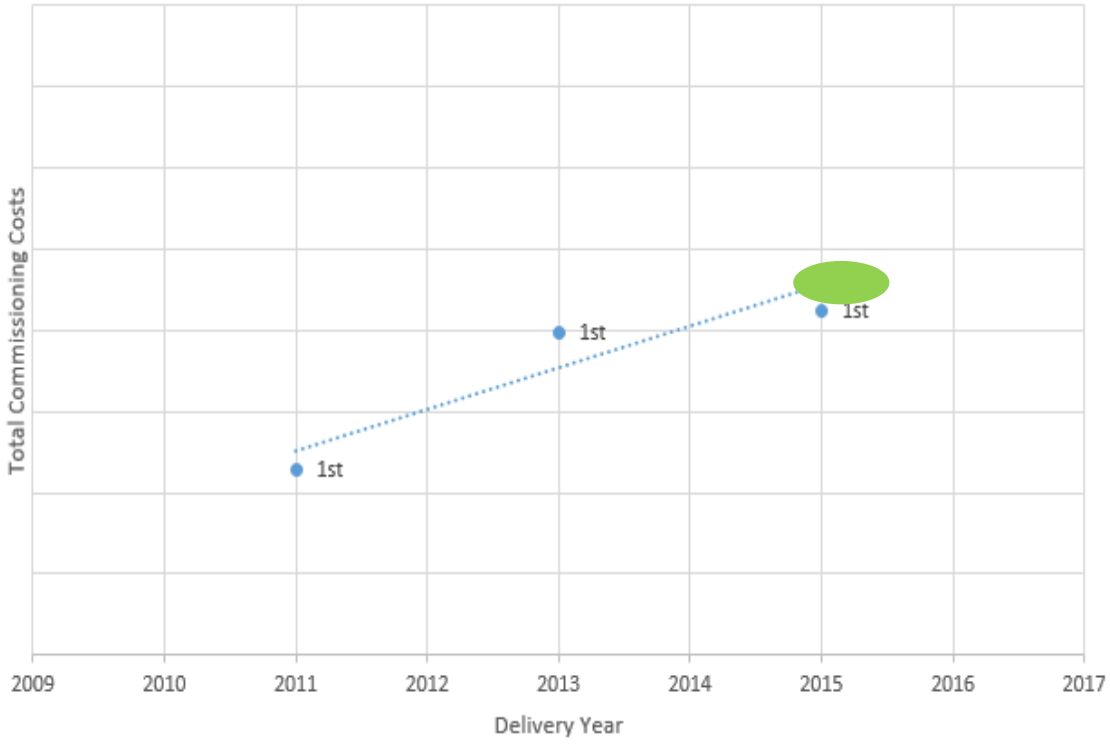

Figure 18. *Total commissioning costs of the class six projects from 2009 to 2017.*

4.3.2 The numeric orders of the vessels effects to the commissioning costs

As the previous figures present, the project type affects the total commissioning costs. The next hypothesis is to find how much the repeat project effect affects to the commissioning costs. It is already known that the pilot vessels are more expensive than the repeat ones, but there is no data about the effects of commissioning costs.

The pilot vessels are more expensive than the repeat ones because the system's design is new and lots of changes have to be done during the commissioning phase due to engineering errors. Changes have to be done so that the entire system fills all regulations and contractual terms. In the repeat vessels there is no need for costly design changes. This causes the big gap to the series' first and repeat vessels' costs.

Figure 19 presents the commissioning cost difference between the series' first vessels and repeat vessels. Both types are set to the same chart to clear the differences. The axis and scale are defined as previously, so it is possible to compare the different figures. The blue dots in Figure 19 present the first vessels of the series and the orange dots presents the repeat projects.

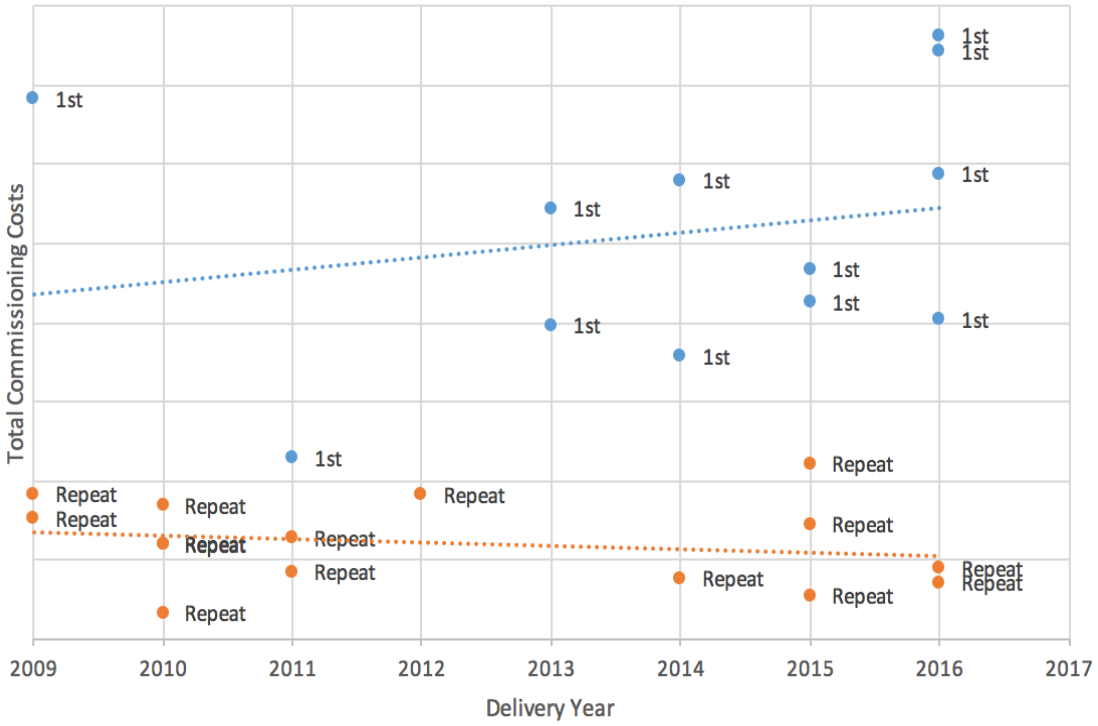

Figure 19. *Commissioning cost difference between series first vessels and repeat vessels*

4.3.3 Customer effects to the total commissioning costs

In the vessel construction, there are many ways to build the vessel. The vessel type affects the construction period. For example, the cruise vessels are more complex than offshore vessels, because in the cruise vessel business the customers demand more high-tech products than in the offshore business. Also, some customers have co-worked with The Company longer than the others. This adds the knowledge of high technology equipment of The Company. These kinds of issues have set customers to different levels and have straight effects to the commissioning period.

In this chapter, the projects are divided by customers in classes four and five to see if the customer affects the total commissioning costs. Two different kinds of customers are chosen to identify this issue. The first customer is one of the oldest business partners of The Company and the cooperation with them has been successful over the years. The second selected customer is very important but there has been a break of few years in business with them.

Figure 20 illustrates the first customer's relations between the total commissioning costs and engineering costs delta. The engineering cost delta in the horizontal axis informs the difference between the original budget of engineering and the fixed costs of the engineering. It describes how much over or under budget the engineering WBS element has run.

The vertical axis describes the total commissioning costs of the project. Typically, over costs in engineering budgets are results from a bad engineering phase.

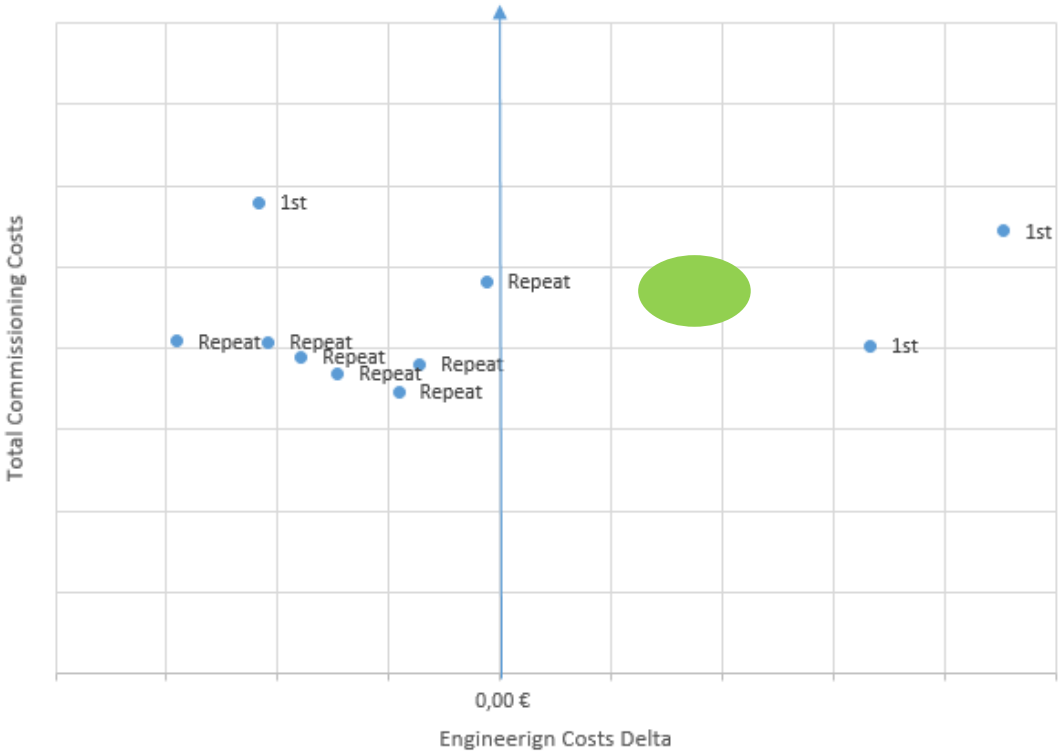

Figure 20. *Projects of Customer 1 and relations between the commissioning and engineering.*

As Figure 21 describes, in similar kind of project scopes as in Figure 20, pilot projects require more engineering during the commissioning period than the repeat ones. The repeat projects engineering delta costs have been run under the budget. The green marked repeat project has modifications requested by customer causing extra engineering costs.

Figure 21 presents the projects delivered by customer 1 during the period. The horizontal axis describes the delivery year of the vessel and the vertical axis shows the total commissioning costs. As the chart illustrates, the pilot vessels cause more commissioning costs than the repeat projects. In 2016 delivered pilot vessel has been a success, because the total commissioning costs are reduced to the same level as the repeat project. Also, the differences between series first and repeat projects are notable. The slope of the trend line has slowed down the growth and the slow growth is possible to explain with the increased standards of living.

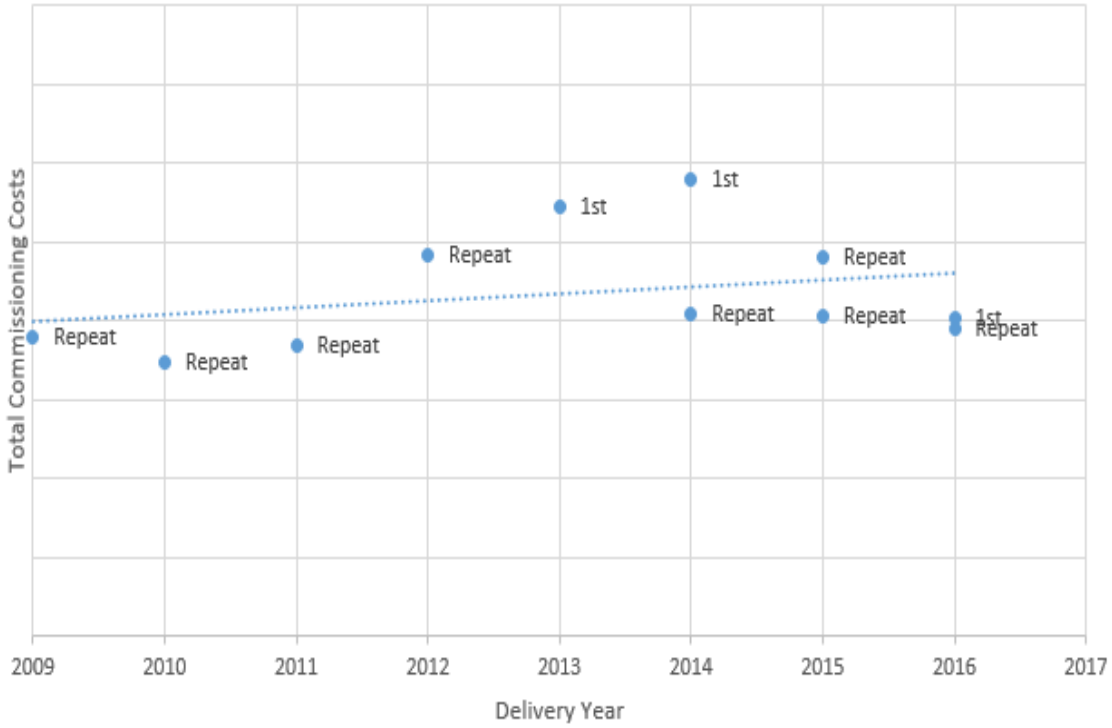

Figure 21. *The delivered projects of the customer 1 and the commissioning costs from 2009 to 2017.*

Figures 20 and 21 demonstrate that there are no major changes in the commissioning costs of the customer 1. During the years from 2012 to 2014, some projects' commissioning costs have raised too high, but now the cost level has stabilized to the same level as the repeat projects in 2009. This shows that right moves have been done and the right track has been found. The threat could be if the quality of the commissioning work has been decreased and all the problems will be boomeranged during the warranty phase. Then the costs of the poor work will be moved forward.

Figure 22 presents the same things with the same scale as Figure 19, but the data is related to the customer 2. There are less projects, but the projects have same kind of technical scope than in the customer's 1 projects. There is a bigger gap between the customer 2 repeat projects and the pilot vessels. The repeat projects are not included in the same series (Figure 23), but as the chart informs the pilot projects are almost two times more expensive than the repeat ones even the scope of the projects have stayed the same. Also, the engineering costs in new projects have run two times higher than before, but the costs are still at the same level as customer 1 engineering costs. The engineering costs point that there have been lots of problems during the commissioning phase, because the engineering costs and the commissioning costs are risen. Also, the commissioning costs of the old red marked repeat projects are at the same level as the costs of the customer 1 repeat projects. This might indicate that the way of working of the customer has changed. The change in the working could be for example the change in the working culture,

change in the construction process or change in The Company's knowledge of the commissioning process.

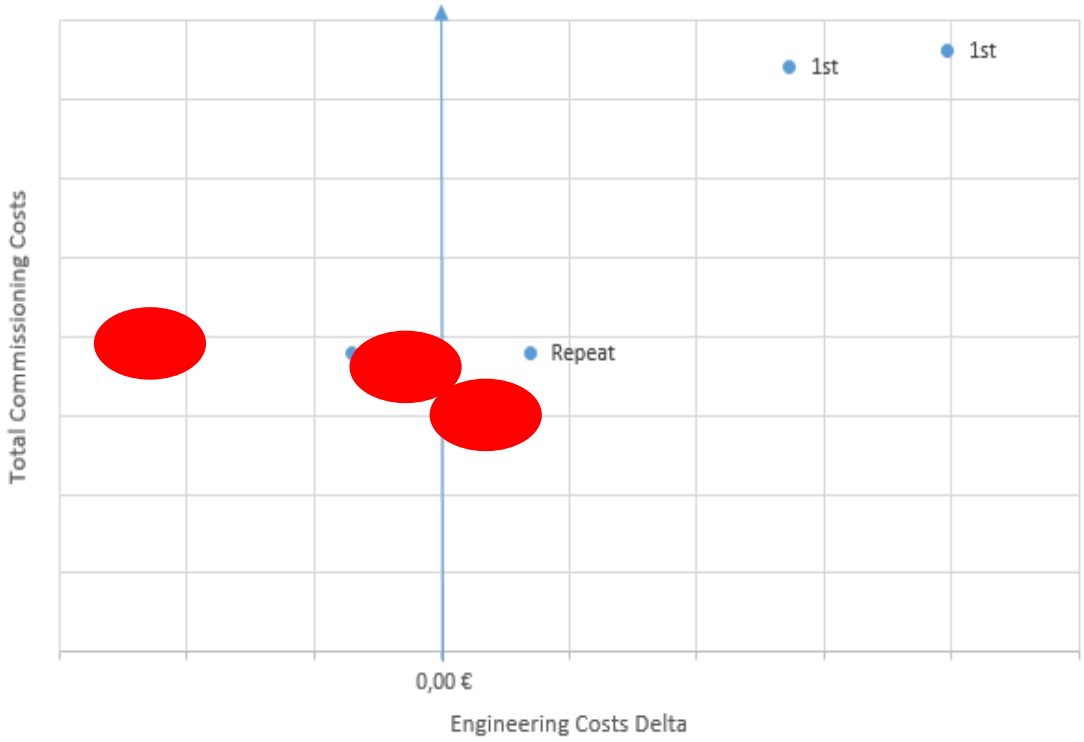

Figure 22. *Projects of Customer 1 and relations between the commissioning and engineering.*

Figure 23 illustrates the development of the commissioning costs of the customer 2 from 2009 to 2017. The axis and scale are the same as in Figure 15. It is possible to notice that there has been a four-year break in the deliveries of the projects and in 2016 two new projects have been delivered. The commissioning costs have been doubled in four years. There are no technical or contractual reasons for this. The pilot vessel is always more expensive than the series' repeat vessels but doubling the commissioning costs in four years cannot be explained with increased standards of living costs. Both inspected projects are marked in Figure 24 with a red mark. The most expensive project in Figure 24 had a full-time site manager, but it did not help to reduce the costs of the commissioning. The gap between the most expensive project with full time site management and the second expensive pilot vessel in Figure 23 with part time site management is not significant. This might be signalling that the Company's site management function is not effective and profitable.

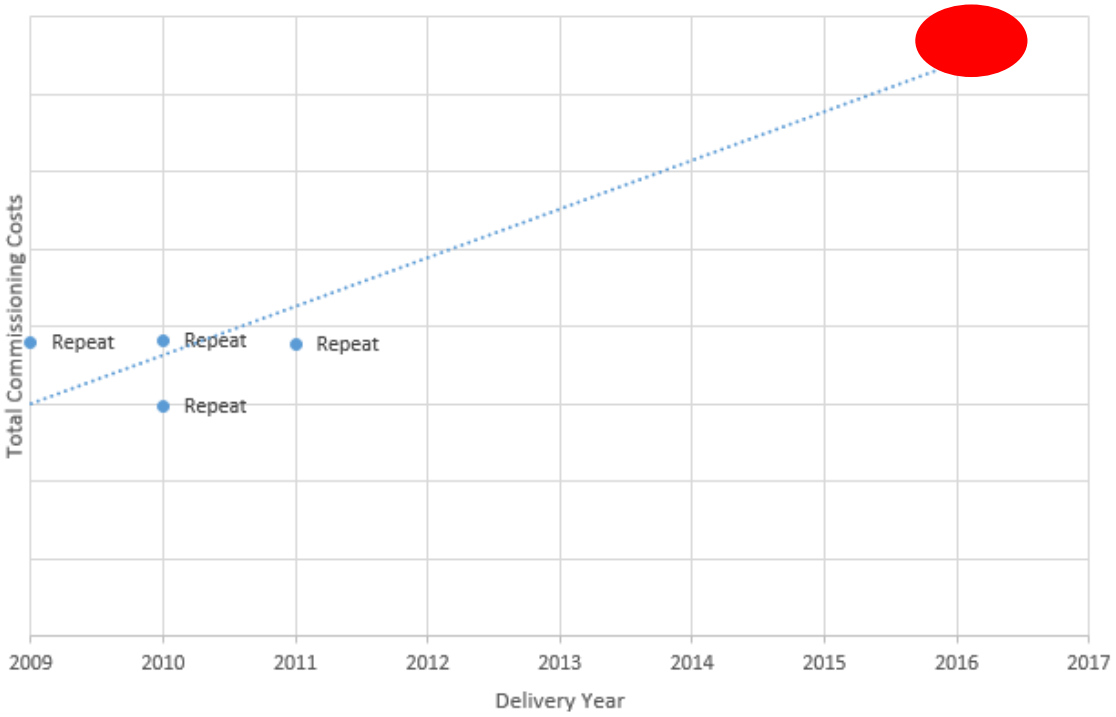

Figure 23. *The delivered projects of the customer 2 and the commissioning costs from 2009 to 2017.*

4.4 Results of the analysis

As the analysis in chapter 4.3 presents, the commissioning is under control in most of the project types and there is no need for full time site management. As Figure 17 presents, the most problematic project types are classes four and five, because the total commissioning costs have increased fast. Another hypothesis indicates that the pilot vessels cause more costs than repeat ones (Figure 19). The pilot vessels are always more complex than the repeat vessels and in the project, business developing new offerings and making changes always cause extra costs. In the repeat vessels, there is no need for changes because it is possible to use the same design than on pilot vessels. For the survey, it is suitable to select the projects from the most problematic classes four and five.

The most interesting finding is how the customer affects the total commissioning costs. When comparing Figures 20 – 23 it can be seen that projects of the customer 2 have caused more commissioning costs than the ones of the customer 1. This difference must be investigated in the survey, because there is no rationalistic reason for why the costs of the commissioning of the customer 1 are two times lower than the commissioning costs of the customer 2.

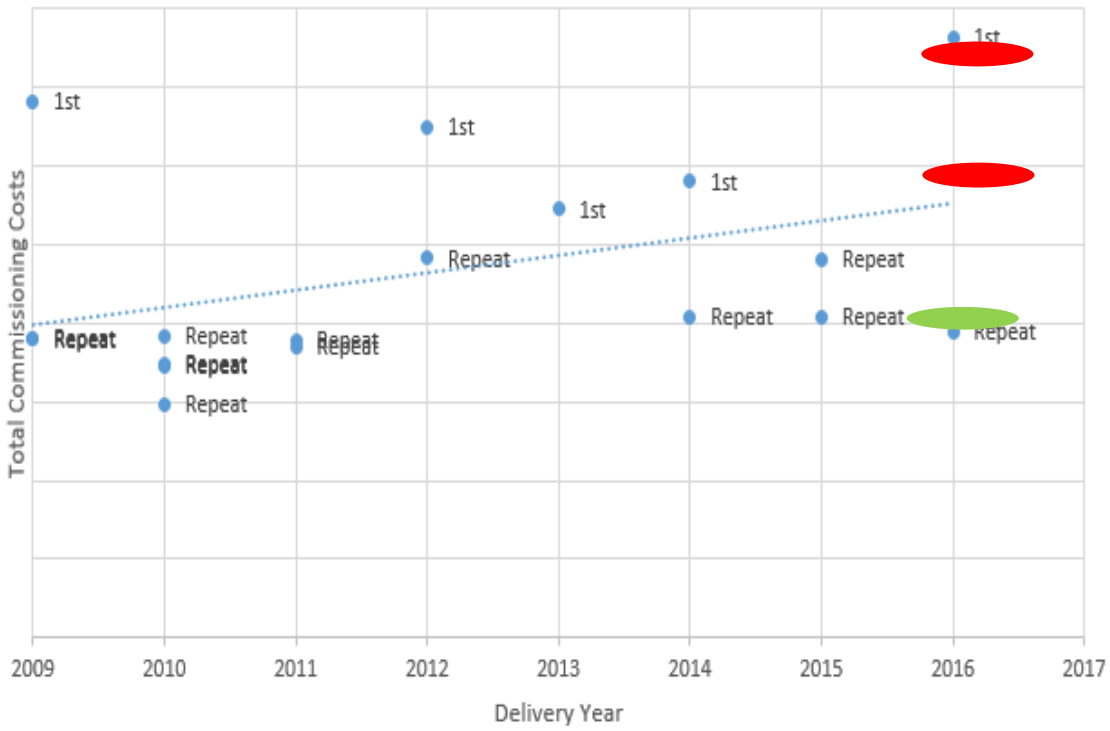

Figure 24. *Selected projects for the survey*

Three different kind of projects for the survey specified in chapter 5 are selected. The selected projects are marked in Figure 24. All of the projects are delivered in 2016 and they are pilot vessels from different customers. In Figure 24, there are different marks for identifying which commissioning are led by a full-time site manager and which ones by a part time site manager. The green colour identifies part time and red colour full time.

5 DEVELOPING NEW SITE MANAGEMENT FUNCTIONS

Currently, the site manager's role and tasks are undefined. This causes the situation that every site manager works without clear frames for the work. Working without frames causes differences in the quality of work. Some site managers have developed their own tools and ways to work. Some of the tools are working great. When using different tools at different sites it is difficult to compare the results of the commissioning. The idea of the arranged survey is to develop frames of the site manager's work and to specify what kind of tools would help the commissioning process.

5.1 Designing the interview

The survey was conducted as semi-structured, because it was found to be the best way to support the second research question. In a semi-structured interview, the researcher does not follow a strict question order and not all the questions are defined specifically. The questions follow specific themes, however. The semi-structured interview was considered suitable because the theme is totally new and there is no existing data from this area. With an interview reassembling to an open discussion session, it is possible to give room for the interviewees to freely form their answers and to get authentic information, while eliminating too leading or defining questions. However, the main questions were kept the same in order to ensure that the interview sessions followed the common thread. (Boyatzis 1998; Brewerton et al. 2001; Hirsjärvi & Hurme 2008)

The themes of the interview are connected to the theory part of this thesis and the structure of the commissioning process. The interview starts with the questions regarding internal commissioning kick-off-meeting. What kind of information is handed to the commissioning team and what kind of improvements need to be made? The questions of the second topic concern the customer commissioning kick-off meeting. At the moment, there are no strict rules of what kind of information needs to be handled in these meetings to ensure that commissioning teams get all necessary information to start the commissioning. The third topic was related to the commissioning phase. It was divided to three subtopics which are necessary and discovered by The Company:

- Safety
- Leadership and communication
- Supply chain management and facilities.

These topics were selected with the management of The Company to be sure that all the site management issues are covered. The interview ends to the project close out meeting

to find out what kind of information needs to be given to be able to develop the commissioning work. The interview consists of 20 questions. Appendix D contains all subjects and questions which are asked from the interview group.

5.2 Conducting the interview

The interview aims to collect data from different views from the organization to ensure that every groups needs regarding site management can be fulfilled. The preliminary plan was to interview three project's commissioning teams which are defined in the chapter 4.4 and one project's commissioning group which is not contained in this thesis work for internal use only. The interview group contains project manager, lead engineer, site manager and commissioning engineer. The total amount of the interviewees is 16, but two internal workers and one external person refused to answer or they did not respond to the interview request. The interview was conducted for 13 internal people and the answers are divided by position:

- 4 Project Managers
- 4 Lead Engineers
- 2 Site Managers
- 3 Commissioning Engineers.

The answering percent is wide and covers good quality for the results. Before the interview it was agreed with the interviewees that all the answers are presented anonymously in the survey. The interviews were executed as face to face interviews. If the interviewee was located abroad the interview was handled on the phone. The interviews were held in an isolated room so that the anonymity of the interviewee could be guaranteed. A typical length of the interview session was approximately sixty minutes. The interviews were conducted in June 2017 and the interviewing language was Finnish.

5.3 Interview analysis

The data of the interviews were collected during the discussions. Also, all interviews were recorded. Afterwards the information from the records were written down to help analysis and to recognize the main points.

When the interviews were written down it was easier to compare the answers of the same level employees. The results are presented in mixed order to protect the anonymity of the interviewees.

5.4 Results of the interview

The results of the interviews are presented according to the topic. Also, some technical details are cut down to assure The Company's privileges. In this chapter, the project

team's results are presented first and after that the site team's results are shown to see what kinds of tasks need to be developed for the site manager to be sure that all the needs will be filled.

5.4.1 Internal commissioning kick-off meeting

Four project managers were interviewed for this research the interview's first subject was conducted to the first commissioning meeting. The internal commissioning kick-off meeting split the answers a lot. All interviewed project managers said that the meeting is useful, but only two have held the meeting on time with agreed agenda. The project managers thought that the problem is that there is no strict follow up agenda for the meeting. Now every project manager can hold a meeting with their own agenda and the company only wants to verify that the minutes of the meeting (MOM) template is signed.

The idea of the meeting is to present the project and rules to the commissioning team and especially to the site manager who is responsible for the commissioning. The meeting should work as a backbone for the site manager. One project manager informed that the structure of the internal kick-off meeting should contain four main subjects: content of the commissioning work, safety issues, contractual terms and details of technical scope. The site manager should know the contractual terms of the commissioning and contractual milestones. These aspects will improve the commissioning work with the customer, scheduling, planning and safety during the commissioning phase. The project managers informed that the FAT claims should be presented in the meeting better. This might help the commissioning process. Also, the mandatory reports to the office should be agreed on in this meeting.

Two project managers informed that the best way to handle scheduling is to make a preliminary schedule with the site manager during the meeting. This guarantees that both side's opinions are noticed. The site manager can concentrate on ensuring that the schedule is realistic and the project manager can ensure that all contractual deadlines are noticed. The preliminary scheduling can help with the budgeting and scheduling of the workers. It would be important to get the latest scheduling updates from the customer to make the preliminary schedule more realistic.

Four interviewed lead engineers answered that the internal commissioning meetings were not held retrospectively. They also agreed with the project managers on how the internal commissioning kick-off meeting helps site manager's job when all mandatory things like technical issues, contractual terms and project scope are presented and site teams get familiar with the project team and the project. Also, all the lead engineers said that the whole commissioning team should participate in the kick-off meeting, because it is the best meeting to get familiar with the project and each other. Two lead engineers weighted that the internal commissioning kick-off meeting is also a suitable moment to give technical materials to the site team and to answer the site team's technical questions. The site

teams and especially site managers attendance has been minor. One lead engineer presented a new proposal. It would help the commissioning work if all new modifications of the equipment and FAT claims could be presented in the meeting. Also, all lead engineers told that the preliminary schedule should be done during the meeting by the site manager to ensure that the current plan is realistic. The specific schedule would help with the detailed planning of the commissioning budget. Three lead engineers also told that there should be a specific list for the subjects that should be clarified in the commissioning kick-off meeting, because now every meeting is held with different subjects and this causes quality differences.

Two site managers said that the internal commissioning kick-off meeting is a rewarding meeting if it is held on time. One site manager said that there were projects where the internal commissioning kick-off meeting was skipped and it caused many problems during the commissioning phase. Now there have been situations where all changes have not been given before the meeting and this has caused lots of issues in the commissioning phase. Solution could be that the participating group of the meeting should be bigger. All technical people of the project from office should participate in the meeting to give support to the site team, because it is important to present the current status of the project and what is agreed with the customer and how it will affect the commissioning. Both site managers wish that the FAT claims could be presented in the meeting to help indicate what kind of preliminary work should be done before the commissioning phase. Both site managers also told that the biggest current problem is the scheduling. Now, the schedule will often change during the commissioning depending on the work culture of the customer. These kinds of issues should be discussed during the meeting.

All three commissioning engineers told that their hectic work style prevents them from participating in the internal commissioning meetings, but they considered the kick-off meeting necessary, because it is the best moment to get familiar with the project team before the commissioning phase. This will help communicating. Commissioning engineers suggest that the meeting could be more technical, because the general contract information regarding the projects does not help their job. The meeting could be presented following a specific template and it should be divided to the management and technical parts. Commissioning engineers wish that the lead engineers of the sub systems could participate in the meeting. This could help knowing what was the current technical status of the project. The site manager's role in the meeting should be to get familiar with the new people.

5.4.2 Customer commissioning kick-off meeting

All project managers informed that the mandatory commissioning kick-off meeting is held rarely. The participants should include project manager, lead engineers and site manager from The Company side and the key players from the customer side. The idea of the

meeting is to ensure that the customer and commissioning team have common rules, communication methods and schedules. Three out of four project managers informed that there should be contract and schedule review in the meeting to ensure the common rules. One project manager told how the customer changed the schedule during the commissioning because there was no consensus between the parties. Also, it should be agreed what reports customer should sign.

All lead engineers told that the customer commissioning kick-off meeting was held rarely, because some of the project managers think that the meeting is not mandatory. Lead engineers told that the main outcome of the meeting has been consensus regarding the schedules, logistic issues and communication. The site manager is important to get presented to the customer. One lead engineer suggested that the site managers should present the commissioning schedule to the customer so they can make obligatory changes to the schedules. The customers should also hand over all the safety regulations and information to the site manager. Therefore, the site manager would hand over the information to the commissioning engineers. The commissioning engineers should not participate in the meeting because the presented subjects are not connected to their tasks. Many lead engineers told that the site managers should agree the communication methods, common rules and weekly meetings in this meeting, because then it is easier to execute the commissioning once the consensus is clear.

Both site managers informed that there were projects where the customer commissioning kick off meeting was totally skipped, because the project managers did not have enough time or they did not think the meeting was mandatory. The meeting is important because it is the first moment when the site manager meets the customer's side workers. It is a suitable moment to discuss with the customer what is agreed on and what needs to be done to achieve the targets of the commissioning phase. It is like a moment where the site managers prove that they are suitable to lead the commissioning team.

Two out of four commissioning engineers have participated in the customer commissioning kick-off meeting and it was very unusual. Also, they think that the customer commissioning kick-off meeting does not benefit their work and it would be better if the site manager could inform the safety issues when they arrive at the site. One commissioning engineer said that it would be a good idea if the site manager presented the preliminary schedule to the customer. Then all technical issues could be presented better.

5.4.3 Commissioning phase - Safety

The interview's second part was constructed regarding the commissioning phase. All the interviewed project managers told that site manager's most important task is to ensure the safe working for the engineers during the commissioning phase. The interviewees have a strong similar opinion that site managers should handle these kind of safety tasks:

- Handle weekly safety tours with the customer, make weekly reports, report the results to the customer and to the project manager. Regular reporting improves the office's safety perspective.
- Introduce the site to the first timers and inform what kind of rules are agreed on in the customer commissioning kick-off meeting.
- Ensure that commissioning engineers obey The Company's safety regulations. Some project managers informed that there has been some negligence.
- Inform the customer immediately if there are some safety shortages at the site.
- Ensure that commissioning engineers have passed all mandatory safety courses.

Two project managers speculate that the best situation would be if the whole site team could send the safety improvement ideas to the site manager. This would improve the reporting level. One project manager told that they have problems with the safety report template, because there is no strict check list. Blank document can cause situation that some important safety issues might be passed. The project managers also informed that there are enough safety tools at the site.

The lead engineers had same kind of opinions as the project managers. The site manager's task is to push customer if there is any room for improvement in the safety issues. If the customer neglects the requests The Company's management level could help to push the customer to execute the improvements. The second task of the site manager could be to superintend that the commissioning engineers obey the safety regulations of the company. This is because the lead engineers have noticed that some regulations are paginated at the site. One lead engineer brought out that the clean working environment enhances the safety of the site. The site manager should observe the working environment and report to the site team or the customer if there is any room for improvement in the safety at the site. Two lead engineers told that the current safety courses and procedures are enough but it would be beneficial if the site manager introduced the site's specific safety instructions to the new commissioning engineers.

Site managers told that the site safety has improved a lot in the last few years because the customers have understood the importance of the safety. Site managers said that their most important task at the site is to verify that the commissioning engineers have a safe working environment. The safety tasks are for example ensuring that the workers follow the Company's safety instructions and the working environment fills all The Company's safety standards. Site manager can investigate the environment with safety tours and filling reports, but the current templates do not have clear check lists. It is the site manager's job to decide if the current working conditions are safe enough to work. If the conditions are poor the site managers job is to inform this forward so the company can pull off the workers. One site manager informed how he will have a tour in the vessel before the customer commissioning kick off meeting. In the meeting, it is possible to specify to which things it is necessary to pay extra attention.

Commissioning engineers answered that the safety at the site is at a good level. Three site engineers informed that they have a possibility to improve the safe conditioning at the site. One commissioning engineer brought up how the safety issues should contain alternative points like air, temperature, lighting etc. Site engineers' methods to improve safety issues are for example informing directly to the site managers or filling The Company's formal safety template, but they want more specific rules on how to work in different cases. All commissioning engineers thought that the personal safety tour at the vessel for the new workers is better than the current methods.

5.4.4 Commissioning phase – Communication and leadership

The interview's next subject in the commissioning phase was communication and leadership. The project managers informed that there are lots of things to improve in the current leadership and communication models. They mentioned that the challenge is the communication between the site team and the office. Lack of the communication caused that some of the commissioning engineers did not know the tasks to be executed at the site. This caused the situation that the project team sent useless workers to the yard. One project manager told that the site manager stopped sending the reports in the middle of the commissioning phase and it caused a total information black out at the office. Also, the communication is important inside the site team because the culture of the commissioning engineers affects the results of work. Some cultures need more guidance and more detailed information related to communication of work than others. One project manager expressed that the lack in the internal communication caused situation that the engineers were stand by and waiting the next task to be informed at the site because no one coordinated their tasks.

Project managers told that the site manager's main tasks are to control the commissioning phase and the workers. With good communicating and reporting it is possible to decrease the work load of the project manager.

Three lead engineers described that the current command chain is too complex and messy because there are no clear instructions. Lead engineers told that many customers want to communicate with one contact point, but now it is quite difficult. The site manager could be the customer's contact point regarding the communication and management. The single contact point would improve the communication between the site and the office. Inform what tasks would be the next neck of the bottle. This would increase the amount of relevant and realistic information and it would secure smooth commissioning progress. The simple changes in the scope could be approved by the site manager but the complex changes could be approved by the lead engineer - this would add the authority of the site manager. Delays and slow communication would be avoided. Only detailed information from the commissioning engineers to office would be suitable. The site manager should coordinate the rotation of the workers and the commissioning tasks. This would help to

avoid the extra costs when the idle of work would be prevented. Some of the lead engineers informed that many changes do not reach the project team, because the site manager forgets to inform the project team.

Both site managers thought that the most important tasks in the command chain are daily communication with the customer to find out the latest schedule changes and inform these to the office. The site managers agreed that the official weekly follow up report could help the reporting to the office, because this way it would be easier to track the history. The site manager should be the member who manages schedules of the rotations of the workers. This could affect the commissioning costs positively. Both site managers said that the current communication model works well, but they wanted to weigh that the copy of the message should be sent to the site manager in order to keep the site manager as updated as possible. If the communication and leadership model can be fixed in the correct way the commissioning engineers do not have to handle all small alternative tasks by themselves.

The commissioning engineers also said that the current command chain is too complex and messy, because there are no strict rules to follow. Now the commissioning engineers communicate directly with the office or via site manager and sometimes this causes information black outs and it is difficult to find the correct contact person. The site managers should handle also the communication with the customer. This could decrease the alternative communication with the customer and they could concentrate on their work. The commissioning engineers told how the working is more difficult if the site manager is external, because they may not know the organization of The Company too well. The commissioning engineers have noticed that the customers do not respect the external site managers as much as an internal site manager. Commissioning engineers informed that it works well when the site manager coordinates the rotation of the workers. This way it is easier to inform when there are enough tasks to do. Site manager can also re-coordinate the workers to the new tasks at the site if some sudden schedule changes appear. The commissioning engineers would get familiar with the new equipment and this would increase their technical knowledge. The site manager should also forward the schedule changes to the site team.

5.4.5 Commissioning phase – SCM and facilities

The current way to handle logistic issues caused headache to all participants. There are no relevant or strict working methods to manage logistic issues. Current methods increase the costs because the warranty logistic does not work smoothly. After the project delivery, a big amount of warranty parts was disposed.

The project managers informed that the current logistic procedures contain too much bureaucracy and the current lead time for the incomplete deliveries and warranty parts is too long. All the orders are made by supply chain department of The Company and their work

load is too high. This can cause long delays for the deliveries. Project managers said that deliveries have got lost at the warehouse of the customer because of the bad logistic co-ordination. There has been defective information from office to site and it is the most common reason for this. Two project managers informed that the site manager should handle all the warranty part handling including ordering new parts, returning broken ones to the supplier and handling dispatching from supplier. This would decrease the lead time of the process. All of the project managers informed that the site office and temporary warehouses of the commissioning teams are not so clear. Clean environment increases safety and the equipment will not get lost. The site manager should ensure that the facilities are in good order.

The lead engineers told that current logistic methods do not work. They validated same reasons as project managers. Three out of four lead engineers told that it would help the situation if the responsibility of the logistic of the warranty parts would be transferred from the office to the site manager. It would also help the lead engineers' work when they would not have to make the purchase requests to the purchasers. Two out of four lead engineers speculated how the site manager can handle all the small purchases at the site. This would decrease the delay of the logistic. The lost parts also cause problems for all the lead engineers. The solution for these kinds of lost parts could be a follow up template where all dispatched items would be listed. When all necessary information is collected to the template it easier to see the current status of the logistic.

The site managers informed that the logistic delay depends on the supplier. Some of the suppliers can deliver the goods fast, but the delay is too long for other parts and the slowness is the office's bureaucracy's fault. If the logistic coordination for the warranty parts will be transferred to the site it will add the extra work for the site managers. The site managers informed that the biggest problem with the lost deliveries is that the office forgot to inform the delivery schedule to the site manager or the goods are delivered to the site too early and then they will get lost.

All commissioning engineers told that their work has been interrupted because of delayed parts. The reason for the protracted delivery is the bureaucracy of the office. Also, the commissioning engineers have to suspend their work because they had to handle the deliveries of the warranty parts. This will cause extra costs. Some parts have been lost because the specific commissioning engineer has not been receiving the delivery. The best solution for this would be that the site manager would handle the logistic coordination with the office and he will be responsible for the logistic of the warranty parts. The missing consumer products can decrease the working level.

5.4.6 Project close-out meeting

All the interviewees informed that the project close-out meeting is rarely held. The reason for this is that some of the project managers thought that the project will end when the

vessel has been delivered. The project process does not simplify what is the real ending point of the project. The other issue with the project close-out meeting is that the project management is overloaded. Straight after the delivery of the vessel the project team will move to the next project. The project managers informed that the close-out meeting template is not filling the needs of the meeting and the "lessons learned" way of thinking is not in the focus. Now, the meeting is more like presenting the financial figures of the project. All the project managers agreed that the meeting would be good if the site team, especially the site manager, could present the development ideas from the site team. One project manager informed that the project close-out meeting would be perfect for the sales team so that they could improve the contracts based on the ideas of the site manager.

The lead engineers told that the project close out meeting could support the improvements of the commissioning process, if the meeting was held. The lead engineers weighted that the site teams should express their ideas more and all the development ideas should be presented in this meeting, because sometimes the close-out meeting has remained trivial. The site manager should definitely participate and express the site development ideas and greetings from the customer to the project team. The project close-out meeting is the kind of meeting where the development ideas can be brought up - it is important to invest in it.

The site managers informed that the close-out meeting would be very valuable to the site manager and for the project team, because it is the best meeting to get and give feedback. The site managers underlined that all technical engineers/managers should participate, because the site team has lots of questions and feedback. The meeting should be driven by the project manager, but the site managers should have their own part to tell greetings from the site.

Most of the commissioning engineers told that the close-out meeting is often skipped. The typical way to end the project is to deliver the vessel and after that everyone will continue working with the new projects. The commissioning engineers told that sometimes the project manager forgets to invite the commissioning engineers to the meeting. A suggestion for this situation could be improving of the meeting structure and making the meeting mandatory. The commissioning engineers also criticized that the meeting concentrates on financial aspects too much. There should be more technical parts to develop the commissioning and maybe some detailed group sessions. The site manager's task could be to bring all the improvement ideas of the site team to the management and to lead the discussion. They should also give feedback to the project team to improve the commissioning phase.

5.4.7 Other subjects of the interview

After the official phase the interviewees had the opportunity to bring up other subjects which are not included to the themes of the interview. The most common question was:

is the fulltime site manager needed in all projects? All interviewees presented the same opinion - if the complexity of the scope of the system delivery is simple, the fulltime site manager is not needed, because the full-time site manager would only increase the costs on simple project. If the scope is too wide and complex, the part time site manager does not have enough time to handle the supervision and management work besides his own commissioning work. If the scope is simple and co-work with customers works, there is no need for a fulltime site manager.

Another popular subject was open claims of the project after the delivery of the vessel. Some of the project team members informed that it would be better if the site manager would handle the open claims instead of the warranty manager, because the site manager knows the claims best. This means that the site manager would act like a termination manager.

One project manager proposed that the site manager should handle the accommodation for the commissioning engineers at the site. This would cause savings when the whole site team could be accommodated to the same place and the volume discounts would be possible.

5.4.8 Results of the interview

Results of the interviews present that all the interviewees highlighted on the importance of the internal commissioning kick of meeting and the meeting should be kept on time. It would be good if the kick off meeting would be categorized as mandatory, because it works as a backbone for the site team and helps the communication. Interviewees informed that there is no structure for the material and the meeting should contain five main subjects: making schedule with the site manager, content of the commissioning work, safety issues, contractual terms and details of technical scope (including the status of the FAT remarks). The whole commissioning and project team should participate in this meeting. Also, one possibility could be to arrange separate meetings for the management and technical subjects.

All the interviewees present that the customer commissioning kick-off meeting is held rarely, because there are no ready-made templates. Common opinion is that the meeting is important because it might be the first time when customer meets the commissioning team. All interviewees agree that the manning of the meeting should be site manager, project manager, lead engineer and the customer representatives. The idea of the meeting is to ensure that both parties have common rules, communication methods and schedules. It would be good if the contract, schedule review and safety regulations can be agreed in this meeting.

Commissioning period was split to different sub subjects: safety, communication, leadership, supply chain management and facilities. All interviewed project managers specified that the most important task of the site manager is to ensure safe working environment. This contains importance of the regular safety observation tours and reporting. These improve the safety at the site. Site manager should be the main responsible person at the site to ensure that commissioning engineers obey the safety regulations of the Company. The site managers responsibility is to inform the customer if there are some safety shortages. If commissioning engineers should inform all the safety improvement ideas to the site manager this would improve the reporting level and some hazards risks could be avoided.

Common opinion of the interviewees was that the existing communication model is too complex, messy and there are no clear instructions. Nowadays the customers want to communicate only with one contact point, but without site manager it is impossible. The improvement ideas for the communication are listed below:

- Help commissioning engineers with their job and ensure that they have all necessary tools and information available.
- Enquire the current situation from the customer to guarantee continuous report flow to the office to avoid the information black outs at the office, because status reports and phone calls are almost the only way to be aware of the status of the commissioning.
- Handle almost all communication with the customer's construction department and site team.
- Inform the project team about the changes and new decisions from the customer side.
- Be sure that the customer knows the communication regulations to ensure the efficiency of the information flow.
- Approve small changes by themselves and forward major changes to the project manager. In detailed technical issues the commissioning engineers can contact the project team directly.
- Coordinate and schedule what kind of engineers are needed and when and send unemployed workers back home.
- Coordinate the commissioning engineers to ensure the deadlines and that there is enough work for all workers.

All parties agreed that existing logistic method is causing too much challenges to all parties, because there is no relevant method to manage logistic issues. Delayed parts postpone the schedules and interrupt work of the commissioning engineers. Current way of handling warranty parts causes high cost for the project, because the logistic of the warranty parts does not work. All interviewed parties informed that the correct way to solve this issue is that the site manager should handle all the logistics of the warranty part including ordering new parts, returning broken ones to the supplier and handling dispatching from supplier. This would decrease the unnecessary work of the project manager and

improve the lead time of the warranty parts. Also, some kind of follow up sheet should be made where different parties can track the situation of the logistic. This would increase the tracking of the parts and decreases unnecessary communication.

The parties also informed that the cleanliness at the site is insufficient. Clean working environment increases the safety and the equipment will not get lost. Clean environment increases working atmosphere also. Interviewees says that the site manager should be responsible of the cleanliness of the site office. This should contain weekly housekeeping inspection and verify that all tools and equipment are placed correctly.

Last subject of the interview was the project close-out meeting. All parties informed that the meeting is rarely held, because some project managers think that the meeting is not mandatory. Project process of the team of project executions doesn't clarify if the meeting is mandatory or not. Otherwise the parties agreed that the close-out meeting is one of the most important milestones of the project, because there the "lesson learned" happens. But the parties say that the existing agenda of the meeting is concentrating too much to present the financial figures of the projects. All the project managers agreed that the meeting would be good if the site team, especially the site manager, could present the development ideas from the site team. The close-out meeting is a good opportunity to give feedback for the project team and especially for the sales team.

Interviewees had an opportunity to bring up other subjects which are not included in the subjects of the survey. The most popular discussion was regarding if a fulltime site manager is needed. The opinion was common. Fulltime site manager is not needed if the complexity level of the project is simple, but in the complex project deliveries fulltime site manager is needed. Another popular topic was the warranty claims. The Common opinion was that the site managers should have responsibility to close the claims instead of warranty manager, because site manager knows the claims best.

6 CONCLUSIONS

The purpose of this thesis work is to develop the site management function of The Company by detecting the insufficient project types and developing new tasks to the site manager. The results of the insufficient project types are collected by analysing total commissioning costs of the executed projects. The tasks of the site manager are developed with the help of the results of the semi-structured interview. In the following chapters, the study and the results are evaluated. The recommendations for further development are also given.

Literature presents the commissioning, site management and the end parts of the project very lightly. The majority of the studies and journals focus on the main phases of the project. However, some studies regarding the commissioning part of the project exist but they are related to power plants. Power plants have a quite similar project structure as vessels projects. Both of them have a complex scope with similar type of electrical equipment and requirements, the lead time is long and the sites are usually located abroad.

The research questions were presented in the chapter 1. The first research question was "For which projects is site management most crucial?" and the second one was "Which kind of tasks the site manager should execute for improving the site management function?"

Answer for the first research question is not so unambiguous. The Company's commissioning structure reminds the ad-hoc commissioning. The commissioning process is similar to troubleshooting and impulsive working, especially in the project type of class 5 and 6, while it should actually be a well-managed phase of the project. Experienced and talented senior workers were interviewed and informed that the commissioning worked better earlier when the size of the commissioning team was smaller and there was no need for the rotations of the workers. The cost analysis indicates and proves that the current commissioning working methods worked well with the small projects, but the complex project types (classes five and six) cause the biggest losses. Figures 15 and 16 prove that the commissioning costs have stayed below the limits. Therefore, the development of the site management is not the direct answer to all the questions, but it will be one part of the whole process. The commissioning process needs to be re-defined.

Figure 13 provides information about the performance of the commissioning – it is strongly related to the contract of the project. Also, many interviewees informed that contractual knowledge is underestimated at The Company and developing the contractual knowledge is important in order to increase the budget savings in the commissioning phase. This will need strong co-work with the sales department so it is possible to find all contractual root causes in order to improve the results. If a fulltime site manager is

necessary, the site management can be considered in the full cost calculation by adding the costs of the site management to the preliminary budget plan.

Figure 11 presents that the design strongly inflates to the first commissioning stage (pre-commissioning stage). The interview presents that the information which is presented in the kick-off meetings is not exact enough or the important information is missing. When there are shortages in the design information it will be reflected to the commissioning costs, because it will cause ad-hoc type commissioning. To develop these things, it is necessary to co-work with the engineering teams to have all the design factors covered. After the construction phase (customers scope), the site manager could have a meeting (for example handover) with the engineering team where all the technical issues would be listed. Before the commissioning start, the site manager should have a tour at the ship-yard to be sure that all required prerequisites are done before the commissioning.

The answer for the second research question is based on the results of the interview. Because of 360° type of interviewing method all level of projects' stakeholders were interviewed and ideas were collected together. The most important improvements of the commissioning phase were of safety, leadership, communication and logistics. Safety improvements concern reporting from the site to the office, safety tours and ensuring that the co-workers follow The Company's safety regulations. All the interviewees informed that the current leadership model is too complex, because The Company does not provide leadership model to the commissioning. Now the leadership model of the site management is project manager specific. This causes differences in the quality of management of the project execution. The communication methods and procedures are also a problem in the site management and the reasons behind it are the same as in the leadership. The communication model is missing and there are no tools for reporting. This causes the lack of the knowledge between the rotations of the commissioning engineers. The reporting tools should be improved together with the different parties. Also, all the interviewees criticize the current logistic procedures, because some deliveries have got lost or there have been problems with the return deliveries from the site. During this thesis one logistic improvement project was executed. The result of the work was a new process which makes the coordination of the return deliveries of the warranty parts and the marking of the faulted parts easier.

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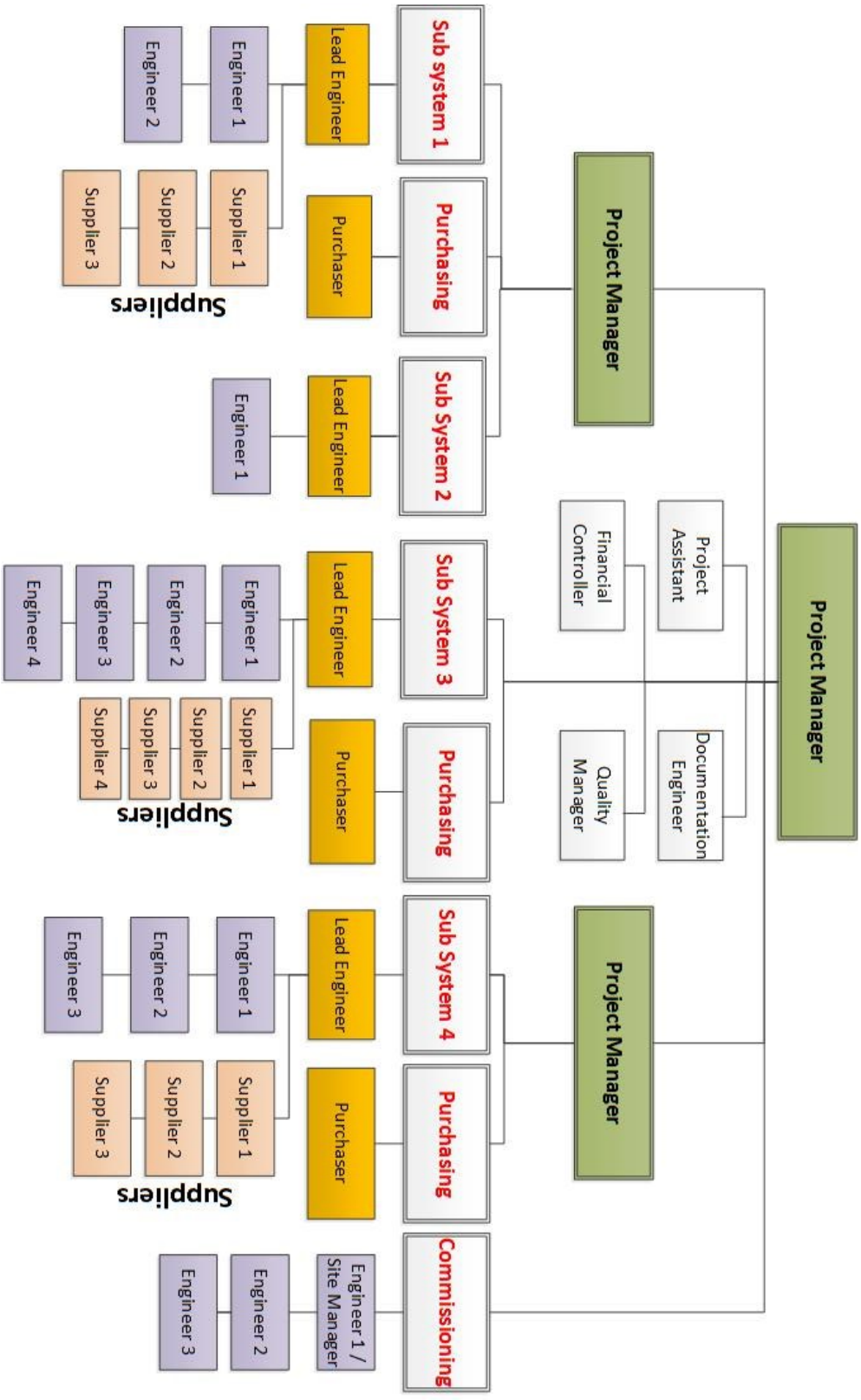
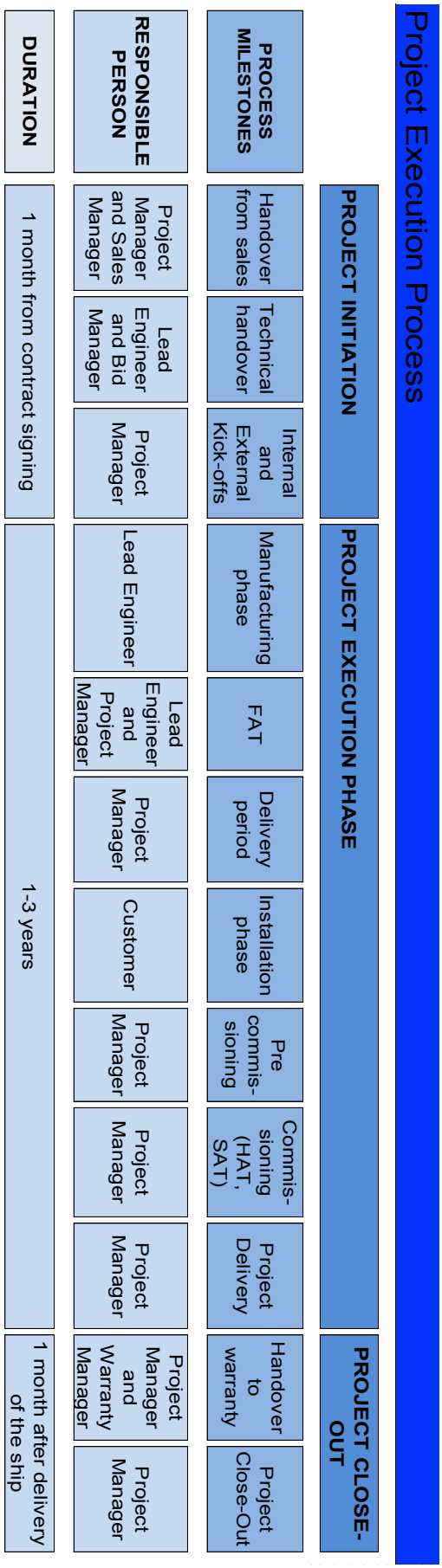
APPENDIX A: EXAMPLE MARINE ORGANIZATION CHART



APPENDIX B: MARINE PROJECT EXECUTION PROCESS



APPENDIX C: PROJECT MANAGEMENT TEMPLATE

Project name	Commissioning time window	Commissioning As Sold	Commissioning Actual	Commissioning Delta	Commissioning Procentual Difference
Project 1					175%
Project 2					172%
Project 3					164%
Project 4					92%
Project 5					128%
Project 6					138%
Project 7					102%
Project 8					122%
Project 9					119%
Project 10					146%
Project 11					110%
Project 12					114%
Project 13					114%
Project 14					103%
Project 15					109%
Project 16					120%
Project 17					96%
Project 18					155%
Project 19					92%
Project 20					97%
Project 21					112%
Project 22					153%
Project 23					261%
Project 24					147%
Project 25					155%
Project 26					309%
Project 27					184%
Project 28					114%
Project 29					77%
Project 30					131%
Project 31					105%
Project 32					78%
Project 33					90%
Project 34					85%
Project 35					137%
Project 36					54%
Project 37					45%
Project 38					63%
Project 39					70%
Project 40					24%
Project 41					37%
Project 42					47%

Commissioning Engineering	Commissioning Travel	Commissioning Quality	Total Commissioning costs	Total Commissioning Costs Delta

Shipyard	Project Type	Ship Number	Complexity	Site Management	Size of Com. Team	Contract type	Engineering As sold
S1 Customer 2	Type 1	1st	5	Part time	11	All inclusive	[illegible]
S1 Customer 2	Type 1	1st	6	Full time	11	All inclusive	[illegible]
S1 Customer 2	Type 1	Repeat	5	Part time	4	All inclusive	[illegible]
S2 Customer 1	Type 1	1st	5	Part time	4	Hourly/day rate	[illegible]
S1 Customer 2	Type 1	Repeat	5	Part time	4	All inclusive	[illegible]
S1 Customer 2	Type 1	Repeat	5	Part time	4	All inclusive	[illegible]
S1 Customer 2	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S3 Customer 3	Type 1	1st	6	Full time	8	Capped	[illegible]
S3 Customer 1	Type 1	1st	6	Part time	8	Capped	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	1st	5	Part time	6	All inclusive	[illegible]
S3 Customer 1	Type 1	1st	6	Part time	5	Capped	[illegible]
S1 Customer 1	Type 1	1st	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	1st	5	Part time	6	All inclusive	[illegible]
S1 Customer 1	Type 1	Repeat	5	Part time	6	All inclusive	[illegible]
S1 Customer 3	Type 2	1st	3	Part time	7	Capped	[illegible]
S1 Customer 3	Type 1	1st	5	Full time	11	All inclusive	[illegible]
S1 Customer 3	Type 1	Repeat	5	Part time	10	All inclusive	[illegible]
S1 Customer 3	Type 2	Repeat	3	Part time	7	Capped	[illegible]
S1 Customer 4	Type 1	1st	4	Full time	15	All inclusive	[illegible]
S5 Customer 2	Type 2	1st	2			All inclusive	[illegible]
S5 Customer 1	Type 4	1st	3	No	4	Capped	[illegible]
S3 Customer 2	Type 1	1st	6	Full time	6	Capped	[illegible]
S1 Customer 3	Type 2	Repeat	3	Part time	7	Capped	[illegible]
S4 Customer 1	Type 2	1st	1	Part time	6	Capped	[illegible]
S5 Customer 3	Type 4	1st	3			Capped	[illegible]
S2 Customer 2	Type 2	1st	2			Capped	[illegible]
S3 Customer 1	Type 3	1st	1	Part time	6	Capped	[illegible]
S5 Customer 2	Type 4	1st	2	No	3	All inclusive	[illegible]
S1 Customer 2	Type 2	1st	2			All inclusive	[illegible]
S5 Customer 4	Type 4	1st	3			Capped	[illegible]
S1 Customer 2	Type 2	Repeat	2			All inclusive	[illegible]
S4 Customer 2	Type 3	1st	1				[illegible]
S1 Customer 2	Type 2	Repeat	2			All inclusive	[illegible]
S1 Customer 2	Type 2	Repeat	2			All inclusive	[illegible]
S4 Customer 3	Type 2	1st	2			All inclusive	[illegible]

Engineering Actual	Engineering Delta	Engineering Procentual difference	Procentual Commissioning engineering	Delivery of the vessel	Engineering Costs During Commissioning
		149 %	20 %		
		126 %	15 %		
		22 %	39 %		
		88 %	18 %		
		125 %	97 %		
		84 %	9 %		
		102 %	4 %		
		80 %	76 %		
		75 %	73 %		
		80 %	5 %		
		166 %	9 %		
		55 %	38 %		
		97 %	88 %		
		181 %	35 %		
		95 %	22 %		
		77 %	16 %		
		33 %	59 %		
		122 %	16 %		
		53 %	39 %		
		176 %	24 %		
		55 %	28 %		
		120 %	14 %		
		73 %	99 %		
		140 %	4 %		
		100 %	34 %		
		182 %	25 %		
		305 %	31 %		
		285 %	12 %		
		89 %	33 %		
		99 %	26 %		
		95 %	28 %		
		73 %	17 %		
		112 %	11 %		
		103 %	18 %		
		365 %	3 %		
		77 %	8 %		
		74 %	38 %		
		63 %	22 %		
		87 %	7 %		
		103 %	24 %		
		39 %	20 %		
		180 %	6 %		

APPENDIX D: SITE MANAGEMENT INTERVIEW

Internal commissioning kick-off-meeting

1. Was the internal commissioning kick-off meeting held on time? If not, why?
2. What kind of information did you learn (co-workers, responsibilities, tasks, scheduling etc.)? and what was the main outcome of the meeting?
3. What kind of challenges were faced? Was there any missing information (unrealistic schedule, unknown communication model etc.)?
4. How did the internal kick-off-meeting support the risk analysis and HSE issues?

Customer commissioning kick-off-meeting

5. Was the external commissioning kick-off-meeting held on time? If not, why? Did you participate? If not, why?
6. How did the schedule of the customer change the original plans?
7. How did the customer present the safety rules? Did it change the working methods?

Commissioning phases (Commissioning stage 1&2)

Safety

8. How has the site manager influenced the safety of the site (any improvements)?
9. How could the site manager improve safety issues?
10. Was the safety information comprehensive enough at the site? If not, what do you think was missing?

Leadership & Communication

11. Describe the current command chain of the commissioning phase (complexity, functionality etc.)?
12. Before arriving at the site, did you know tasks required from you and what to do next? If not, why?
13. Were there any changes in the schedule? How did you react to the changes?
14. What is your opinion on the current communication model? (Each commissioning engineer communicates directly with the lead engineer and the project management.)
    a. Part time SM – Customers communicate directly with engineers
        i. Suspension of the work?
        ii. Suspension of the work?
        iii. Concentration level?
        iv. SAT and HAT tests?
    b. Full time SM – Customers communicate directly with site manager
        i. Knowledge of the site manager?

15. Did the variation of the workers cause lack of knowledge? How could this be avoided?
16. Did the updated information (/changes) reach you? How could successful flow of information be ensured?
17. Was it easy to make improvement proposals? If not, why?

Supply chain & Facilities

18. Was the logistics too slow and complex for the incomplete deliveries or warranty parts? If yes, how could this be improved?
19. Was the storage (customer warehouse or site office) clear and clean or did the parts get lost? Were there other issues and how could these be improved?

Project close-out meeting

20. What kind of feedback did you receive? Was it useful?