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**PROFITABILITY ANALYSIS OF POTENTIAL EPC – PROJECT DELIVERY IN  
MARINE ASSET MANAGEMENT**

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## TIIVISTELMÄ

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### **Profitability analysis of potential EPC project delivery in Marine asset management**

Diplomityö

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75 sivua, 9 kuvaa, 12 taulukko ja 2 liitettä

Tarkastajat: Professori Juha Varis  
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Hakusanat: EPC, toimitusmalli, vertailu

Tutkimuksen tarkoituksena oli tarkastella Wärtsilän Marine Asset Management osaston Engineering, procurement ja construction eli EPC-projektien kannattavuutta ja selvittää kohdatut ongelmat EPC projektitoimitusmallissa. Käsiteltäviä projekteja oli yhdeksän ja näiden projektien lopullinen tuottomarginaali vaihteli voitollisesta tappiollisiin projekteihin. Projektit olivat toimitussisällöltään erilaisia, mikä osaksi vaikeutti projektien vertailua keskenään

Tutkimuksessa vertailtiin kirjallisuustutkimuksena keskenään erillaisia projektinhallinta menetelmiä, mistä parhaimmaksi kohdeyritykselle osottautui Project Management Instituten Project Management Professional (PMI) sertifikaatti. Projektien vertailussa keskenään käytettiin projektien kustannus seurannasta saatuja tietoja, jotka olivat profit margin, main contract, power generation, common costs, project management, site management ja financial kustannukset. Vertailusta selvisi merkittävimpänä seikkana ongelmallinen seurannan mahdollisuus. Työn tukipilariksi ja antoisimmaksi osuudeksi nousi haastattelut, jotka pidettiin yhdeksälle henkilölle ympäri organisaatiota. Haastatteluissa esitettiin kymmenen kysymystä, jotka sisälsi kysymyksiä aina kokemuksesta projektien talousasioihin. Haastateltavien vastauksista, omasta kokemuksesta ja kirjallisuudesta pystyttiin kehittämään toimintamalli, mitä yritys pystyisi halutessaan hyödyntämään tulevaisuudessa.

Työn lopputuloksena on esitetty malli, joka osallistaa projektiryhmää aikaisin myyntivaiheessa. Työssä esitellään taulukkomallinen esimerkki, mikä helpottaisi tulevaisuudessa myyntiosaston työtä, kun valitaan oikeaa projektien toimitusmallia. Projekteille olisi hyvä saada vakiintuneet käytännöt EPC-toimitusmalleja tehtäessä, joka edellyttää silloin, että projektien riskienhallinta, seuranta, raportointi ja lessons learned dokumentaatio on silloin kunnossa. Myöhemmin tässä työssä Wärtsilää tullaan kutsumaan Target company nimellä.

## **ABSTRACT**

LUT University  
LUT School of Energy Systems  
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### **Profitability analysis of potential EPC project delivery in Marine asset management**

Master's thesis

2020

75 pages, 9 Figures, 12 Charts, and 2 Appendixes

Examiners: Professor Juha Varis  
M.Sc. Tuomas Helin

Keywords: EPC, Delivery model.

The purpose of the study was to examine the profitability of Wärtsilä's Marine Asset Management Engineering, procurement and construction (EPC) projects and to identify the problems encountered in the project delivery model. Nine projects were examined and the final profit margin for these projects ranged from profitable to unprofitable projects. The projects were different in terms of delivery content, which in part made it challenging to compare the projects.

The study compared different project management methods in the literature research, the best of which was the Project Management Institute's Project Management Professional (PMI) certificate for the Target company. Data from the project cost monitoring system were used to compare projects, which were: profit margin, main contract, power generation, common costs, project management, site management and financial costs. The most significant aspect of the comparison was noticed to be the difficult and near to impossible way of comparing the cost. The most rewarding part of the work was the interviews held with nine people around the organization. Ten questions were asked in the interviews, which ranged from questions regarding experience to the financial aspects of the projects. From the answers of the interviewees, their own experience and literature, it was possible to develop an operating model that the company would be able to utilize in the future.

The end result of the study is a model that involves the project team early in the sales phase. The work presents a tabular example, which would facilitate the work of the sales department in the future when choosing the right project delivery model. It would be suitable for projects to have established practices when making EPC delivery models, which then requires that risk management, project monitoring, reporting and Lessons learned documentation is in place. Later on in this thesis Wärtsilä will be referred to as Target company.

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Appendix I: Interview presentation material.

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## LIST OF SYMBOLS AND ABBREVIATIONS

AMS	Asset Management Service
CPE	Chief Project Engineer
CRM	Customer Relation Management
ECPA	Engine Control Plat Automation
EEQ	Engineering and Equipment delivery
EPC	Engineering, Procurement, Construction
EPC-M	Engineering, Procurement, Construction & Management
EQ	Equipment delivery
G	Gate (project-related)
IMRAD+C	Introduction, Materials, Results, Analysis, Discussion, Conclusion
IPMA	International Project Management Association
KPI	Key Performance Indicator
LD	Liquidated damages
MS	Milestone
PDM	Project Delivery Model
PM	Project Manager
PMI	Project Management Institute
PMP	Project Management Professional
PRINCE 2	PRojects IN Controlled Environments
SAP	Systems Applications and Products in Data Processing
SWOT	Strength, Weakness, Opportunities, Threats
UNIC	Unified control

## 1 INTRODUCTION

This introductory chapter explains the concept of the thesis and gives an overview of the project to the reader. The introduction chapter is divided into six sections, After the introduction chapter, this research explains in more detail different project delivery models that Target Company is currently using in their business. Materials & methods of what has been used to obtain enough data to make the results reliable. Results from various studies which can indicate problem areas. Analysis of the results, discussion, and in the end, the conclusion of the thesis.

### 1.1 Background for the research project

Target company's marine business has a strong position in the maritime industry. Today, more than 50,000 vessels operate with one or more installed Target company's products. Target company also provides maintenance services to one out of every three vessels navigating our oceans. Target company's marine business's unique value proposition is presented throughout three value pillars: Energy management, Voyage management, and Asset management. (Wärtsilä, 2019) This research will be focused on Target company's Marine Asset management department projects, and especially on how to improve and develop areas and practices in project delivery.

Our shared passion is to provide the best project management services in the Marine industry. Our external and internal customers recognize that our Project Management team is their partner, competitive, trusted, and easy to deal with, in their projects. We are dedicated to continuously develop our capability and way of working to deliver competitive services in changing market situations adding value to our customers and shareholders. We build our skills and competences to support the Smart Marine Technology strategy. We apply the LEAN principle in our delivery processes by minimizing waste and maximizing value-adding activities. We understand that quality and safety are the fundamental cornerstones of our operations. We are eager to participate in Capture Team selling activities by sharing experience, supporting schedule management as well as cost

management. Expertise areas: Re-Powering and conversions, Engine replacements, Engine Control & Plant Automation (ECPA), SCR's, Low Nox conversions (Wärtsilä, 2020)

The asset management department has a wide variety of projects from engine automation system UNIC (unified control) upgrade to full-scale EPC conversion projects (i.e., converting engines to operate on different fuel types than initially designed). A project might be for one single fishing ship or an entire fleet of vessels that may consist of up to 40 Ships. The value of these projects may vary from 30,000 € to 180 million € or more. When delivery content varies from project to project so much, it requires specialized expertise throughout the supply chain to make the projects financially viable.

## 1.2 Project works

This chapter focuses on the life cycle of the project body and how the whole life cycle is divided into parts. Project Management at Target company follows to a high degree the guidelines set by Project Management Institute (PMI). (Project Management Institute, 2020)

### 1.2.1 Project life cycle

According to Invensis Inc (2020), "A project life cycle is the sequence of phases that a project goes through from its initiation to its closure. The number and arrangement of the process are determined by the management and various other factors like the need of the organization to be involved in the project, the nature of the project, and its area of application. The phases have a solid start, end, and control point and are constrained by time. The project lifecycle can be defined and modified as per the needs and aspects of the organization. Even though every project has a definite start and end, the particular objectives, deliverables, and activities vary widely. The lifecycle provides the necessary foundation of the actions that have to be performed in the project, irrespective of the specific work involved". (Invensis Inc, 2020)

"Project life cycles can range from predictive or plan-driven approaches to adaptive or change-driven approaches. In a predictive life cycle, the specifics are defined at the start of the project, and any alterations to scope are carefully addressed. In an adaptive life cycle,

the product is developed over multiple iterations, and detailed scope is defined for iteration only as the iteration begins”. (Invensis Inc, 2020)

### 1.2.2 Characteristics of the project life cycle

Although projects are unique and highly unpredictable, their standard framework consists of the same generic lifecycle structure, consisting of the following phases:

1. The Initiation Phase: Starting of the project
2. The Planning Phase: Organizing and Preparing
3. The Execution Phase: Carrying out the project
4. The Termination Phase: Closing the project (Invensis Inc, 2020)



**Figure 1.** Lifecycle structure (Invensis Inc, 2020)

### 1.2.3 Project gates

According to Stratton (2003), “project Gates and Project Gate Reviews are both concepts that provide key communication opportunities between stakeholders as projects move through the project processes and application-specific elaboration steps.

Gate reviews provide management specific points in the project life cycle when further progress entails higher investment and commitment. At the Gate Review, the project manager reviews progress made to-date, changes since the last Gate Review, and the plan for the work between this Gate and the subsequent Gate. To be effective, Gates should address the two fundamental causes of project failure, scope changes, and risk. Formal (change order) and informal scope changes (unknown complexity), and new risks and risk assessments should be Gate topics. Gate reviews give management visibility into the project's progress to-date, changes since the last Gate, and the project manager's plan for the near term. At this point, management may let the project proceed, delay, alter, or cancel the project before further work is performed. (Stratton, 2003) As a result of a successful Gate Review, the project manager has obtained the concurrence that the work to-date is satisfactory, the risk is controlled, the scope is being addressed, the plans are sound, and the organization remains committed to the project". (Stratton, 2003)

Stratton (2020) also states, "project Gates are key points in a project where a formal review of the project's current state is performed. Most often, they appear at the phase transitions of projects and represent a point in the project where the sponsor and stakeholders will incur increased risk, expense, and reward. When a project Gate is encountered, a Gate Review is held to determine if the project should proceed or not and under what conditions. Although the Gate Review may appear like a project status meeting, it is much more important". (Stratton, 2003)

#### 1.2.4 Project Milestones

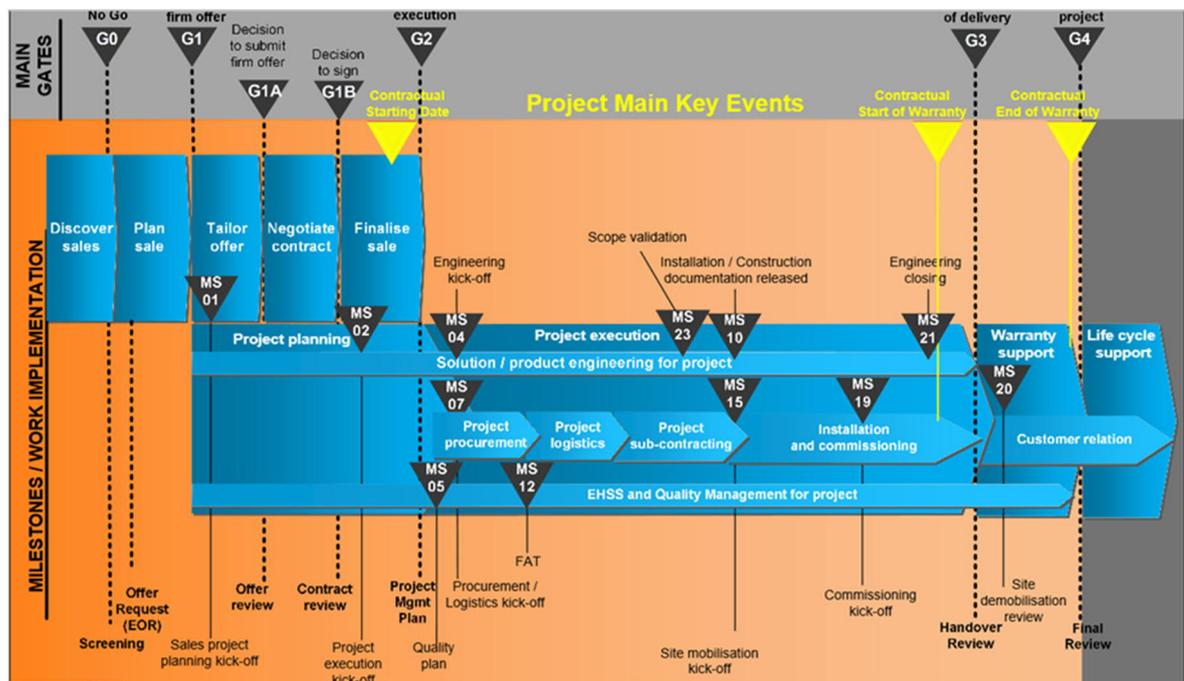
PMI defines project milestones as follows: A milestone anticipates what the project is supposed to achieve at a pre-set date. It should describe a desired state of affairs, the desired future situation. There are two essential aspects to this. First, the concept refers to a point in time, not a period of time. Second, it looks forward to what we want to create, not how we create it.

According Andersen (2006), "many define a milestone as an event in a project, which is not a very sensible definition as it mixes two different things together. A milestone should describe what we want to achieve; when we get there, that's the event. Most people avoid

this level of precision, but by referring to milestones as events, for instance, attention may be diverted from what the project is supposed to achieve or deliver.

Milestones should preferably be felt like a natural part of the project. Of course, what people mean by “natural” depends on their experience and qualifications in subjects of relevance to the project. Natural milestones are, for example, normal decisions and consignments within the type of project we are planning”. (Andersen, 2006)

Target company has developed their own gate model based on this theory, which can be seen in Figure 2.



**Figure 2.** A schematic view of the project life cycle, milestones, and gates used by the Target company as their business process (Wärtsilä 2020)

### 1.3 Project from sales to execution in Target company’s Asset Management Services

For the purpose of clarification, the current process from sales to execution at the Target Company was investigated. This section examines the operation of the Sales Department and the Marine Asset Management Department.

### 1.3.1 Sales

The role of the Sales department is to generate order intake, ensuring growth and profitability, by creating and implementing the sales strategy through the regional sales plans and through country planning for selected countries. The strategy is implemented by setting and following up on targets.

Sales establish and maintain customer relationships and co-ordinate the work of Business Development Managers in different locations, for all products and solutions. (Wärtsilä Oyj, 2019) The sell Solutions process is a systematic and logical series of steps that are expected to result in the completion of a successful project. The underlying goal of any sales process is to secure business for the company. While Target company's sales projects are all unique and vary from one situation to another, the basic elements of each and every step do exist. (Wärtsilä Oyj, 2019)

Sell Solutions process has six main process steps:

- 1) Manage lead
- 2) Discover sales
- 3) Plan sale
- 4) Tailor offer
- 5) Negotiate contract
- 6) Finalize the sale

The sell solutions process has the following gates:

- G0 Go / No-Go
- G1 Decision to a firm offer
- G1A Decision to submit a firm offer
- G1B Decision to sign

The sell solutions process covers the following milestones:

- Proposal planning kick-off (MS01)
- Project execution kick-off (MS02)

The sell solutions process includes the following review activities/steps (sales quality records) in Customer Relation Management (CRM) which is a database where is all following information stored.

- Screening
- Risk & Opportunity
- Offer review
- Contract review



**Figure 3.** Sell solution steps, gates, and milestones. (Wärtsilä Oyj, 2019)

When the sales project reaches MS02, the responsibility for the project is to be transferred from sales to the project manager at the kick-off meeting. At this meeting, sales will hand over all necessary documents and unwritten information to the project team.

### 1.3.2 Marine Asset Management Project Phases

Marine Asset Management divides the project into phases, which have been defined by PMI, these phases are:

“Initiate: Defines and authorizes the project.

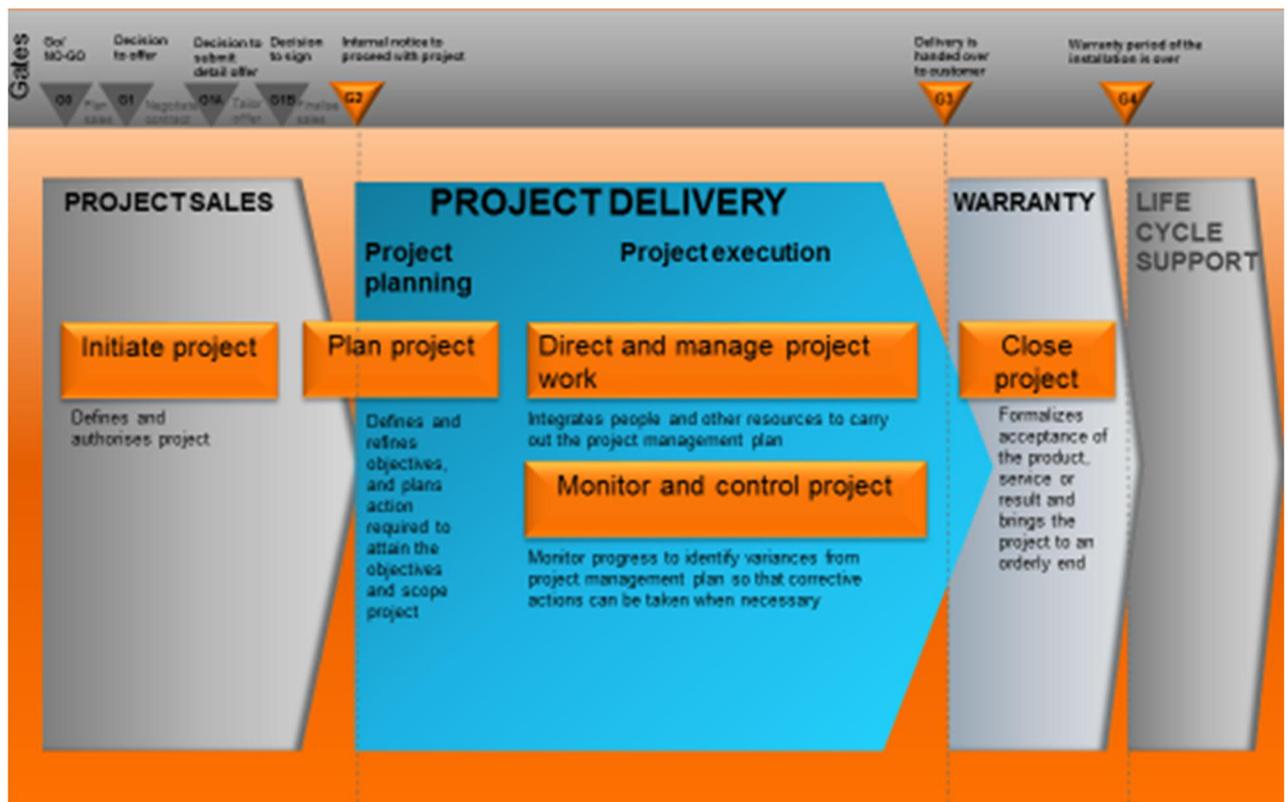
Plan: Defines and refines objectives and plans the course of action required to attain the objectives and scope that the project was undertaken to address.

Execute: Integrates people and other resources to carry out the project management plan for the project.

Monitor and Control:

Regularly measures and monitors progress to identify variances from the project management plan so that corrective action can be taken when necessary to meet project objectives.

Close: Formalizes acceptance of the product, service, or result and brings the project or a project phase to an orderly end and lessons learned are distributed within the organisation. Lessons learned is the knowledge gained during a project which shows how project events were addressed or should be addressed in the future for the purpose of improving future performance”. (Project Management Institute, 2017)



**Figure 4.** Project execution life cycle. (Hägblom, 2019)

#### 1.4 Research problem

Target company's Marine Asset Management department has five different project delivery models, which differ in terms of content. Chapter 2 reviews these delivery models and the criteria for their selection.

According to Ershi (2015) "EPC is an abbreviation for Engineering Procurement and Construction. Under an EPC contract, the contractor is responsible for the design of the project, to procure the necessary materials and for construction. It can be considered as a turnkey contract, and therefore the contractor is also accountable for the quality, safety, schedule, budget, commissioning, and final testing".

Ershi (2015) also states; "There are two main characteristics in this type of contracts are: 1) The structure of the agreement between the client and contractor are succinct, and there is clear division on the responsibility of both parties; there are sub-contracts between the sub-contractors and the main contractor, the main contractor is responsible for the overall process, and 2) The most common pricing method is that the main contract has a fixed given number, which is mostly higher than the prevailing prices in other models; this increases the profitability of the contractors; this usually stimulates main contractors to organize better and plan the overall schedule to ensure higher quality delivery". (Ershi, 2015)

And according to Douglas (2016) "EPC contract forms are selected to realize the inherent advantages provided by an integrated team across the full life cycle of a project from design concepts through to commissioning. Traditional barriers between engineering, procurement, and construction contractors (or variations of this) are eliminated, and the inefficient layering of owners' management teams is avoided enabling rapid and efficient decision and approval processes. This approach seeks to achieve the most seamless delivery organization possible". (Douglas, 2016) This is one of the main reasons why customers are favoring EPC-contracts.

In order to be able to study and justify the answers to a research problem, it must be divided into four parts. These four sub-questions facilitate the perception of the whole of the problem and help to structure the research work.

The four sub-questions are:

- How to define the required competencies and resources to the sales organization?
- How to define best practices for site execution?
- How to define the internal business model end-to-end (sales → execution)?
- How should Target company prepare an offer to an extensive program?

### 1.4.1 Research objectives

The aim of the study is to find areas for development in the current EPC delivery model. In order to understand the EPC delivery model as a whole, the delivery project must be disassembled, and all internal aspects of the project must be considered as separate review items. The study also examines the content of the different delivery models in use and tries to pinpoint the most suitable way of working patterns.

The main point in this research is to find a solution for the question how to develop the EPC-delivery business model in the Target company's Marine Asset management department. This development need has occurred when profit margins have decreased during the project execution phase, and in some cases the profit margin has gone to negative. The study focuses on different aspects of the projects and tries to find the cause and effect of the decline in profit margins and why the profitability has not increased as anticipated by Ershi (chapter 1.4. p.17).

The submission of large EPC projects at Target company's Asset Management is considered to be so risky that they are being avoided.

This phenomenon has created a hypothesis: EPC delivery is almost impossible to make it profitable in a service business without leaving open-end items. The best way to enlarge scopes is to select specific activities that can be sold along with equipment. Corresponding competences should be in house or from close partners. This should be clearly specified in the sales phase.

The study also examines whether the current EPC model is ideal for the marine business, or whether there are opportunities to develop a kind of hybrid business model for the business that seeks to minimize risks while still achieving a similar outcome. To be able to determine the development Targets from the EPC model, the project must be divided into the following activity parts: Sales, project management, construction management, and warranty period. Another focus of this study is on the activities between sales and the project team and the reform of the operating method and operating culture. Site operations and the warranty period are included because these above-mentioned areas are directly related.

After finding areas for improvement, it must be determined how to apply the model with the current configuration, or whether changes need to be made. In this model, the possibilities that are in use must be carefully considered. Research results are invalid if they cannot be utilized in the current setup.

#### 1.4.2 Research limitations

The research is limited to the Wärtsilä Marine business unit and, more generally, to the development of the EPC project model. In order to develop a project model, it is essential to collect data from other project models as well. Comparative data will be collected from EPC projects performed by Marine Asset Management (AMS), but interviews have gathered expertise from a number of different stakeholders across the company and also include external actors.

#### 1.5 Research methodology

*“The first step in solving any problem is recognizing there is one.”* (Sorking, 2012)

In this study, the first step to solving the problem has been taken, as it has been identified that the problem is in the profitability in delivery of EPC projects. The qualitative part of the study includes literature research, interviews, academic article research, and lessons learned research. The quantitative part of the study includes a comparison of the profit margins of different projects.

When an EPC project includes installation design, material procurement, quality assurance, occupational safety, construction, commissioning, scheduling, and budget, together with the sales budget, these sub-areas form the internal tasks of the projects that are under review. In order to find the right point of improvement, the study needs to look at the individual margins of project tasks and make a comparison with other projects. To this study, nine projects were chosen to be compared and studied, see chapter 3.2 Analytic cost comparison from previous projects.

One aspect of the study which was of great interest was to find the best possible approach that is right for Target company. When research is assigned to a specific area of the

company's activity, the evaluation of the results must also be comprehensive. In this study, when analyzing the results and assessing which is the best of the options, it uses SWOT analysis (Strength, weakness, opportunities, Threats).

According to Hindle (2008), "swot is a handy mnemonic to help corporate planners think about strategy. It stands for Strengths, Weaknesses, Opportunities, and Threats. What are the organization's swots? How can it manage them in a way that will optimize its performance? A second four-letter acronym is sometimes brought into play here: used. How can the Strengths be Used; the Weaknesses be Stopped, the Opportunities be Exploited, and the Threats be Defended against on?" (Hindle, 2008)

According to Hindle (2008), "the four features can be divided into two main dimensions:

1. Internal/external. The internal features are the company's own strengths and weaknesses. Analysing them is a matter of analysing the state of the company. They are things that already exist. The external features are the organization's opportunities and the threats to its future performance. These exist only on the horizon, and they are less easy to assess and measure. They arise from things like changes in technology, demography, or government policy.
2. Positive/negative. The positive things are the strengths and opportunities; the negative ones are the threats and weaknesses". (Hindle, 2008)

## 1.6 Research structure

The structure of this study follows the IMRAD (Introduction, Methods, Research, Analysis, Discussion) model.

The Introduction section is divided into four sections. The first part reviews the backgrounds of the study, which explains why the study is necessary. In the second part, the research problem is divided into two sub-sections, which define the research objectives and research limitations. These have been intentionally divided into two parts for the sake of clarity of the study. The third part describes the research on methods, which explains how the investigation will be carried out and what methods are used in data collection. The fourth section presents the structure of the study and tells what is going through in each chapter.

The second chapter, which can still be included as an introduction, reviews and clarifies the current project delivery models used by Target company.

The third chapter, Materials & Methods, is divided into three parts. The first part compares the literature on Target company's current project management plan and compares it with other project management methods in use. In the second part, six projects are examined, for which cost margins are collected, and tables are created to facilitate cost analysis. The third section reviews interviews and interview questions. These interviews help to get a good overview of the challenges, threats, and opportunities for project activities.

Fourth paragraph Results. In this section, all the results from the previous article, from literature research, result margins, and interviews, are compiled into raw data for analysis.

The fifth paragraph discusses the results of the fourth paragraph and analyzes them in depth.

The sixth chapter considers the results from many different perspectives and compares them with the results reported by others. The aim is to find an explanation for the differences and to perform sensitivity analyzes and assess the generalizability of the results.

The seventh paragraph concludes the study. It examines whether the research provided an answer to the research questions and whether the research was able to produce new information. What conclusion was reached at the end of the work and whether it can be utilized and, if so, how to proceed.

## 2 DELIVERY PROJECT MODELS IN TARGET COMPANY

According to Killeq (2017), “project delivery models (PDM) are complex matters, which in turn leads to a variety of different models. This variety represents a challenge in terms of choosing the “right” one, and in findings practices that support and utilize the room to maneuver in the selected model. In practical life, some claim it is best to design a specific model adapted to the unique features of each project and in light of current trends and market situation, i.e., optimize as far as possible in each case. Others claim it is best for an organization to specialize in one specific model and to avoid confusion that follows from changing the model from project to project”. (Klalegg, 2017)

When Target company is deciding on what kind of PDM they are offering to the customer, there are several aspects which are considered. As stated earlier, also Target company has created five different PDM: s to their offer portfolio. These PDM: s is represented in Figure 5.

The customer’s wishes about the scope and content of the delivery, very much determines the delivery model with which the sales start to proceed. With the current operating model, the sales department evaluates whether the delivery model desired by the customer is the best option for the company or whether the offered model should include some other delivery model.

When deciding which PDM is most suitable for the project there is two concepts what has to be opened more, and those are: basic engineering and detailed engineering.

Farayand Sazan Energy Consulting Engineering Company describes basic engineering as follows: “Basic engineering involves the establishment of the basic technical concepts, criteria and standards for a project, the type and size of plant, the process and equipment to be used, allowances for future additions or expansions, and the degree of mechanization and automation to be used in the plant. selected licensor will implement basic engineering of the

licensed unit for the typical project. activities will essentially be continued during extended basic engineering stage. (Farayand Sazan Energy Consulting Engineering Company, 2016) Present group describes detailed engineering in their web-page as follows: Detailed Engineering is the phase in project implementation that applies all technical disciplines needed (i.e. mechanical, civil, electrical, piping, automation, telecommunications, instrumentation, etc.) to establish the set of deliverables. This means that the project is inching closer to reality and ideas are transforming into actual, tangible and specific entities. In detailed engineering design, every component, subsystem and part relevant to the project is properly documented, procured and implemented. While the project viability is determined in basic engineering, every detail concerning the entirety of the project including end-user satisfaction and functionality are covered in detailed design.” ( Powertech Pty Ltd, 2019)

### 2.1 Equipment delivery

Equipment delivery (EQ) model is the narrowest of the models, so its workload for the project team is minimal. Such a delivery model can be used if, for example, the customer has professional expertise from his own, so much that the customer can do the installation and commissioning themselves. Of course, the limitations of these deliveries are product warranty issues. Target company does not warrant certain products or equipment that are not installed or commissioned by a Target company’s authorized person. A technical feasibility study is optional but not usually included in EQ-PDM.

### 2.2 Equipment delivery & basic engineering

Equipment delivery & basic engineering (basic EEQ) includes equipment, project management, and basic design scope. Optional to this model can be added technical feasibility study, 3D-laser scanning, installation plan class approval, prefabrication, or installation advisory.

This model is suitable for customers with the right conditions and a desire to lead the construction business. Some customers want Target company to apply the classification for the installation, so it is not uncommon that the installation plan class approval is added to the delivery content.

### 2.3 Equipment delivery & basic + detail engineering

Equipment delivery & basic + detail engineering (Basic + detail EEQ) is already a very comprehensive equipment delivery model. This model includes almost everything you need to start installations. This model is well-suited for customers with the facilities, workforce, and ability to perform even the most demanding installation work. Alternatively, perform preparations or installation supervision, or both can be added to this model. However, if both of these options are chosen, we are already really close to the full engineering, procurement and construction (Full EPC) model.

### 2.4 Full Engineering Procurement and Construction

Full Engineering Procurement and Construction (Full EPC) model is the broadest and most comprehensive of the PDM models used by Target company. The Full EPC model can also be referred to as turnkey delivery. On the EPC engineering website, the EPC model is defined as follows: “EPC stands for Engineering, Procurement, Construction and is a prominent form of contracting agreement in the construction industry. The engineering and construction contractor will carry out the detailed engineering design of the project, procure all the equipment and materials necessary, and then construct to deliver a functioning facility or asset to their clients. Companies that provide EPC Projects are commonly referred to as EPC Contractors. Typically, the EPC Contractor has to execute and deliver the project within an agreed time and budget, widely known as a Lump Sum Turn Key (LSTK) Contract. An EPC LSTK Contract places the risk for schedule and budget on the EPC Contractor.” (EPC engineering, 2016)

### 2.5 Engineering, Procurement and Construction Management

According to Hogan (2016), “in contrast to the EPC model, the engineering, procurement and construction management (EPC-M) contractor is not directly involved in the building and construction of the project but is rather responsible for the detailed design and overall management of the project, on behalf of the owner or principal. While an EPC contract takes the form of a design and construction contract, the EPC-M model can be regarded as a professional services contract.” (Hogan, 2016)

Hogan (2016) continues, “the EPC-M contractor has a duty to ensure that the engineering and design of the project being in compliance with the project’s technical and functional specifications. Supervising, management, and coordinating construction interface in accordance with a detailed schedule is the fundamental responsibility of the EPC-M contractor.” (Hogan, 2016)

Hogan (2016) also states, “the EPC-M contractor is responsible for establishing contractual arrangements on behalf of the owner or principal with other contractors, vendors, sub-contractors, and sub-vendors, through a tender process. The EPC-M contractor is contracted by the owner or principal for the construction management role, while the owner or principal is bound to various contractual relationships for construction-related works. From an owner or principal’s perspective, there lies a disadvantage in being bound to various contractual relationships in the event of a dispute. Unlike the EPC model, the owner or principal will more often than not find itself involved in a dispute with one or more of the other parties relating to the construction of the project, to whom the EPCM contractor must offer assistance.” (Hogan, 2016)



**Figure 5.** Wärtsilä project delivery model scope. (Wärtsilä Scrubber retrofit , 2018)

### 3 METHODS

The Materials & methods section explains how the study began to address the prevailing problem. This section describes the methods used to clarify the outcome of the research and how to obtain the most valid results from the available data.

#### 3.1 Literature study from various sources and comparison to recently used project management methods

Target company aims to use the project management guidelines developed by the Project Management Institute (PMI). The literature search sought to find commonalities and grievances concerning other project management methods. The literature search aimed to find the most important critical points of the projects and to find out exactly what should be taken into account when establishing the project with the current composition. The study did not limit the projects to the marine side only but sought to find common ground between projects in different fields and to pull them together.

#### 3.2 Analytic cost comparison from previous projects.

Nine different projects were used in the comparison. the projects had different delivery content. All were EPC projects. Project contents always ranged from fuel conversions, engine turbocharger replacement, or engine exhaust scrubbers also known as exhaust gas scrubbers.

In this Study, the projects are named chronologically Project 1 ... 9 so that the projects remain anonymous. Larger version of charts has been added to this study and can be found from Appendix II

The data were collected to compare data regime System Application and Products in Data Processing (SAP) using the sell-side Customer Relationship Management (CRM) system, and data produced by projects. The aim was to compare the following project cost elements in the different projects:

- Main Contract

- Power Generation
- Common costs
- Project management
- Site management
- Financial
- Profit margin

The change in margins from sales to project handover was compared within projects and also between different projects. The aim was to find commonalities and apparent coherence between these differences, which would then indicate the most vulnerable point of the projects. These differences are presented in Charts 1-7

### 3.3 Interviews from different stakeholders

The qualitative part of the study was conducted by interviewing people from different departments of the organization. Several professionals participated, in this way, a large sample of the interviews were obtained, which could be analyzed more efficiently. The result is also more reliable this way.

The interview questions are ten and are divided into three subject areas: interviewee background, delivery project model, and project financing.

Interviews were recorded as allowed by the participant, and interviews were conducted using Microsoft Teams. After the interviews, the responses were written clean and accepted by the respondent before being published.

#### 3.3.1 Interview questions

The first two questions determine the professional experience of the interviewee. These questions also clarify whether the delivery modalities of different projects are clearly divided or whether the focus is on specific project formats.

Question 1.

Occupation and work experience in years?

Question 2.

An approximate number of projects, and how they are distributed between different delivery models?

Questions 3-5 focuses on project delivery models. These determine whether the interviewee agrees with the prevailing hypothesis on the Marine side and how to justify it. Are there any similarities between the statements of all the interviewees, and how have they been invested? These questions also try to find out the interviewee's view of the need for co-operation with the sales department. This set of questions provides one of the most important points of clarification for this study.

Question 3.

Do you agree or disagree with the hypothesis (see chapter 1.4.1), and why?

Question 4.

What is your preferred project delivery model (see chapter 2), and why?

Question 5.

What are the most significant bottlenecks areas in the project?

Question 6

How important do you consider the co-operation between the sales department and the project team?

Question 7

How big should be the project team contribution to sales projects?

The last three questions have focused on the financial aspects of the project. With these, we find out how the interviewees see for themselves what is the most challenging in projects in a business sense and what or which things affect it the most.

Question 8.

Which project area consumes most of the profit margin?

Question 9.

Do you see any similarities between the profit margin and other variables of the projects? i.e., delivery country, project scope/scale, marketing segment (oil & gas, national ownership, private ownership), economy cycles (i.e., fast build, no matter on a financial point of view)

Question 10.

What is the main reason for the weak profit margin? (sales, EPC, unforeseen events, subcontracting, LD: s...)

#### 3.4 Lessons learned from projects

Lessons learned (see chapter 1.3.2) contains a review of each aspect of the project and an accurate account of where it was successful and where it went wrong. It is the fundamental purpose of the document that is to find the root cause of the problems so that these errors can be avoided in subsequent projects.

The Lessons learned section in this thesis looks at the documentation produced by all projects. From there, we can determine whether the conclusions drawn by the project on the areas for improvement are in line with the raw data obtained from the study.

## 4 RESULTS

The results of the study and the raw data of the results are presented in this section.

One of the areas to be investigated in the study was to find the best possible operating methods for the construction site. As the research progressed, it became clear that the target for the company had already ordered a master thesis from University of Lappeenranta and thesis has been made 2015: Developing construction site operations for EPC power plant projects by: Mika Nykänen. Since a similar study has already been done on the topic, we, together with the client, considered it unnecessary to re-examine the topic.

### 4.1 Results from the literature study

In the literature study, information, commonalities, and variances were studied and the different project management practices used by Marine AMS (Asset Management Services) were defined.

There are three primary project management certificates that were investigated more thoroughly; Project Management Institute PMI, International Project Management Association IPMA, and Axelos PRINCE2®.

These three mentioned above are training programs in project management, and upon passing, the individual will receive a certificate. All of these are in use in Finland, and it is challenging and even impossible to rank them. The study found that each of these training programs address the most important parts of project management.

#### 4.1.1 PRINCE2®

Projects IN Controlled Environments (PRINCE®) It is a process-oriented project management methodology initially tailored for the British government.

The PRINCE2® methodology is based on seven principles: Business Case, Organization, Quality, Plans, Risk, Change, Progress. Prince 2 focuses on the idea and, at its core, is the business review, product manager, and project management organization on a product-by-product basis. PRINCE2® provides a project management model that is executed through business management and risk management.

#### 4.1.2 Project Management Professional

Project management professional (PMP®) certification is maintained by the U.S.-based but global Project Management Institute. When PRINCE 2 was a business-driven project management model, PMP® is again a process-oriented model. PMP has divided its teaching into ten “knowledge areas,” which are: Project Integration Management, Project scope Management, Project Schedule Management, Project Cost Management, project quality management, project Resources management, project communication management, project risk management, project procurement management, project stakeholder management. (Project Management Institute, 2017)

#### 4.1.3 International Project Management Association IPMA

IPMA maintains a four-tier certification system in which project experts are ranked at different levels according to knowledge and especially experience. In addition to project managers and managers, program managers and (project) portfolio managers are also certified.

The IPMA framework, on the other hand, is competency driven. The certification mirrors the candidates’ competence in the competency elements structured in IPMA’s Competence Baseline. Practical competencies define the “core of project management” competencies such as schedule, budget, and resource management. Human competencies include the personal tendencies of the project expert and such skills related to leading the team and its members as conflict resolution. Perspective competencies define a project in relation to its operating environment, such as a company’s strategy. (Ollikainen, 2020)

#### 4.2 Results from the margin and expense review

There was a total of nine projects in the cost comparison. Project profitability analysis is done by comparing six different financial figures from the reference projects. In Chapters 4.2.1-4.2.7 there are definitions and results of these financial figures.

#### 4.2.1 Project profit margin results

The profit margin in these cases has been calculated by calculating the difference between the final cost of the project and the contract value as a percentage. The columns in chart 1 are percentage shares, while the bars marked in blue are sales expectations calculated by the sales department. The profit margins have been realized in orange. As the bar went down, the project's profit margin went negative.



**Chart 1.** Project profit margin

#### 4.2.2 Main contract

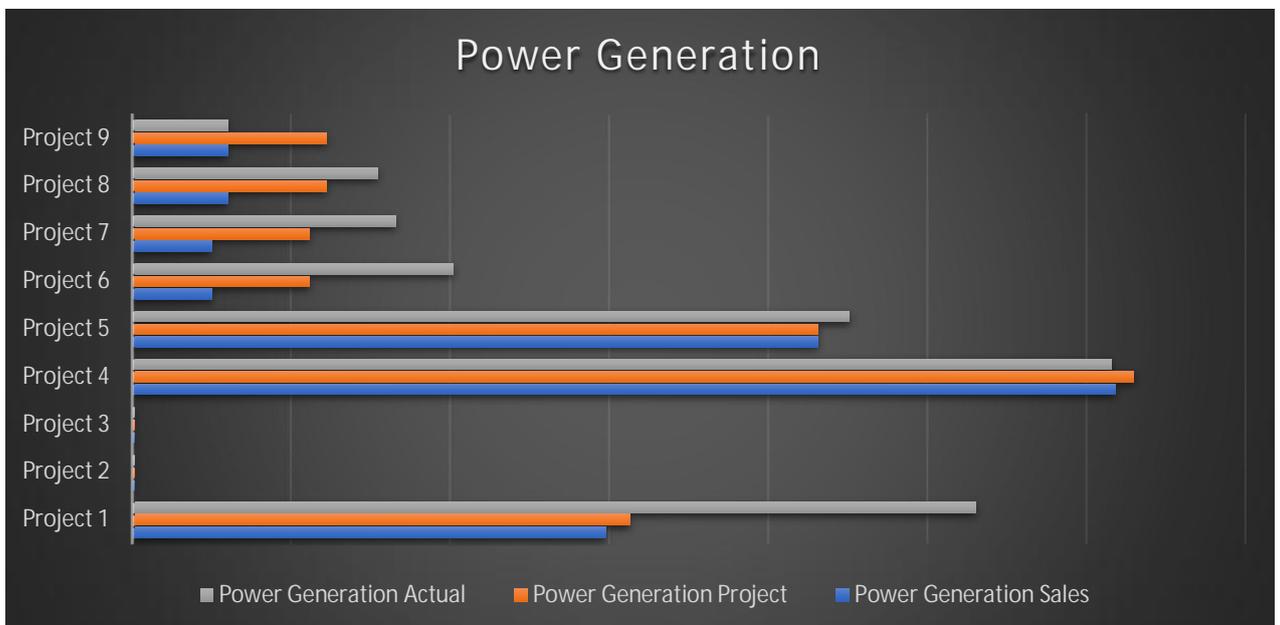
The term main contract cost in this study refers to the total cost of the project. Each project has a comparison of the sales budget cost, the project manager budget cost, and the actual costs. This is top-level in the cost review, so the tables that are reviewed at afterward are included in these costs.



**Chart 2.** Project’s main contract values

4.2.3 Power generation

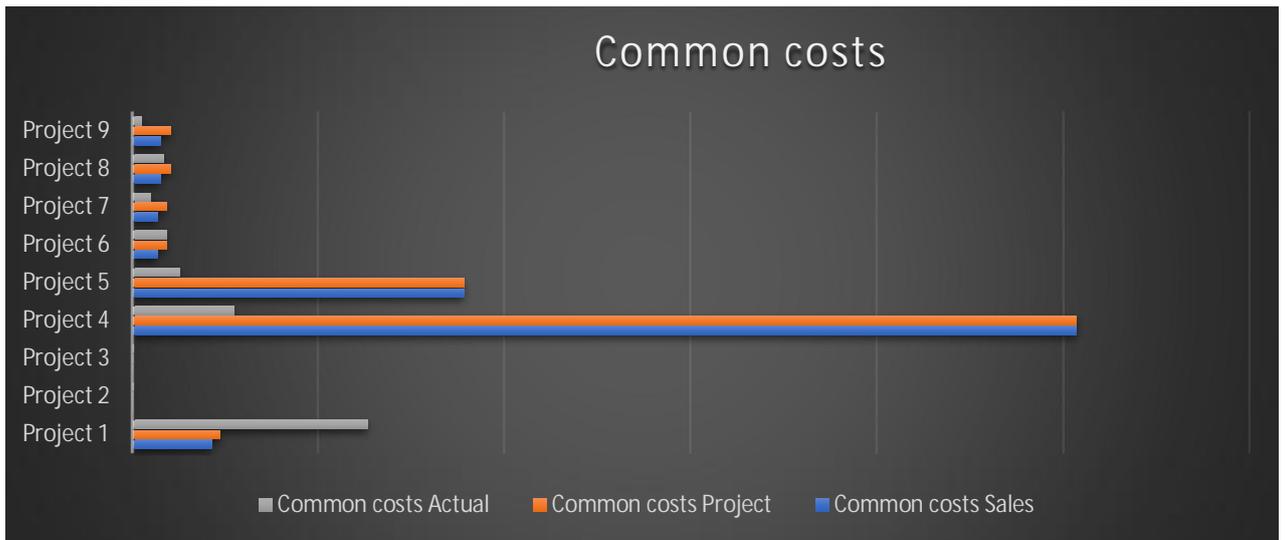
Power generation costs commonly occur in the early stages of the project. Power generation costs include the following values: engineering, procurement, transportation, documentation, and non-conformities. Each chart has three columns, which are the estimates of the sales and project manager, and the actual cost.



**Chart 3.** Projects Power generation costs

#### 4.2.4 Common costs

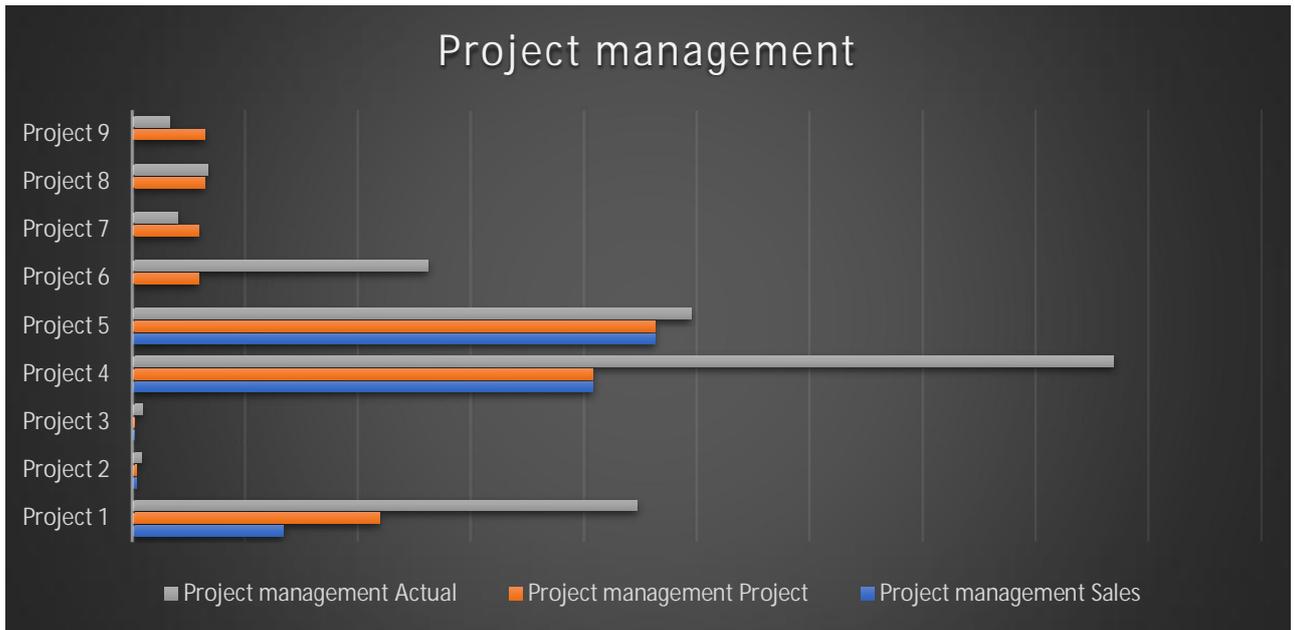
Common costs have been selected for review because it includes costs for project management, site management and site finance. All three will be broken down in the following sections for a better review. Here too, each project is divided into three graphs that describe the sales estimate, the project manager's estimate, and the actual costs.



**Chart 4.** Projects common costs

#### 4.2.5 Project management

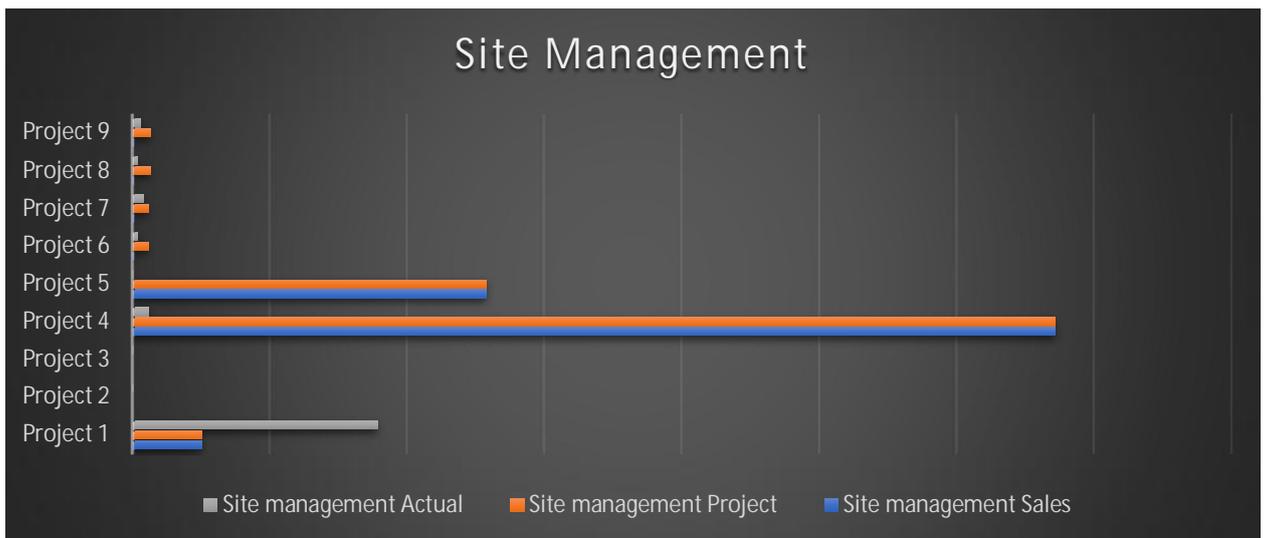
Project management costs include administration, travel / accom., Meetings & represent project management, project engineering, and sourcing & logistics. Each project is divided into three graphs that describe the sales estimate, the project manager's estimate, and the actual costs.



**Chart 5.** Project management costs

#### 4.2.6 Site management

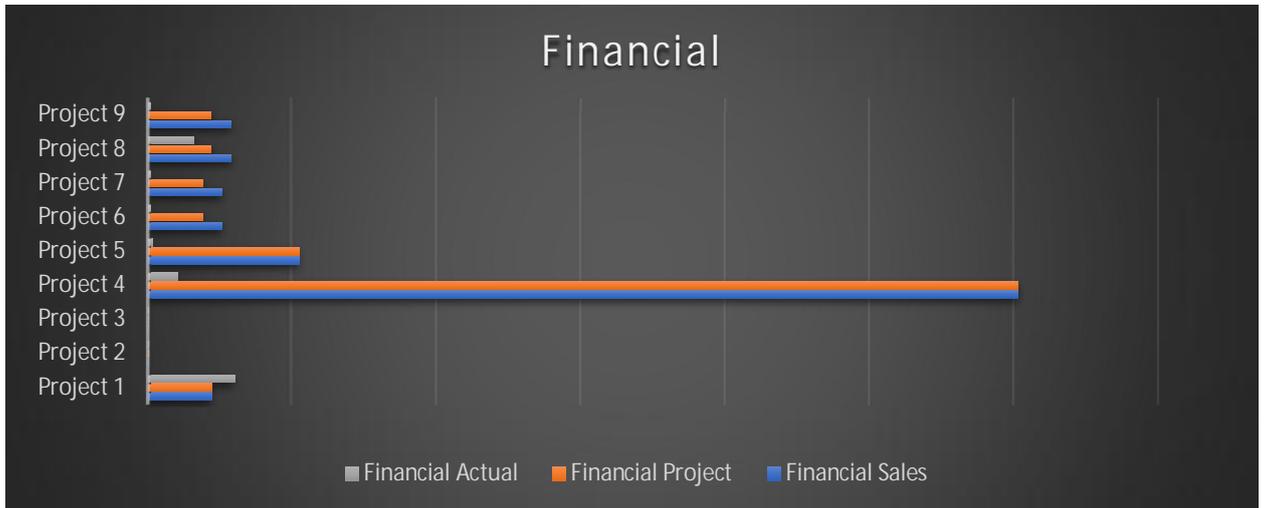
Site management costs include Site material, site management, administration travel / accom., meeting & represent. Each project is divided into three graphs that describe the sales estimate, the project manager’s estimate, and the actual costs.



**Chart 6.** Site management costs

#### 4.2.7 Financial

Financial costs include Financial costs and insurance fees. Each project is divided into three graphs that describe the sales estimate, the project manager's estimate, and the actual values.



**Chart 7.** financial and other costs

#### 4.3 Results from interviews

During the interviews ten questions were presented for each of the nine interviewees. The results of the interview do not go into detail about the exact answers of each interviewee. The results have sought to find the most relevant factor from the discussion which is important for the study. For each of the questions below, there is a short summary of all the answers from each interview. In order to confirm the summary, one or more direct references are made from the interview to that question.

The identities of the interviewees are not disclosed because it was considered that the interviews would not be truthful nor succeed without the interviews being conducted anonymously.

##### Question 1.

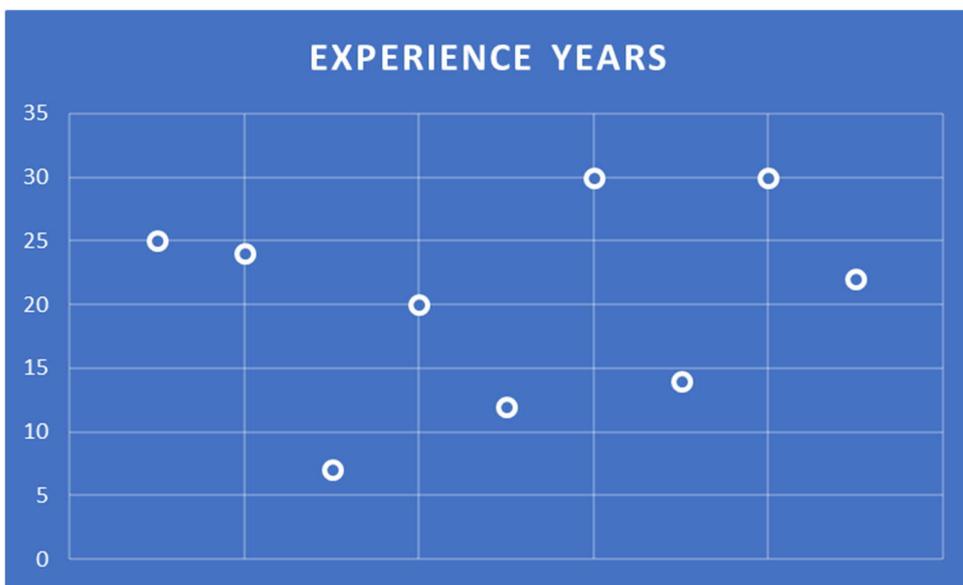
Occupation and work experience in years?

All interviewees have had a very comprehensive career in Target company and in other companies. and a total of 184 years of experience. Many of the interviewees has experience

from both site and office work. The mean number of years of experience for this study was 20.44 years, and the median was 22 years

*“I started working at Target company in the early 1990s. I have worked in power plant construction sites around the world as a Supervisor, Commissioning engineer, and a warranty engineer.*

*Now I have done project work for almost 20 years.”* (Interviewee, 2020)



**Chart 8.** Interview experience chart

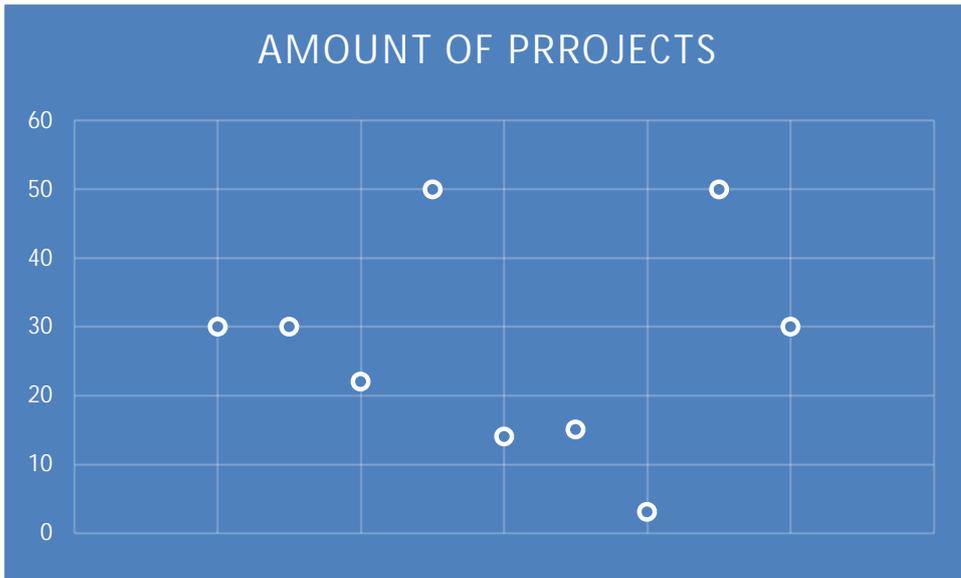
#### Question 2.

An approximate number of projects, and how they are distributed between different delivery models?

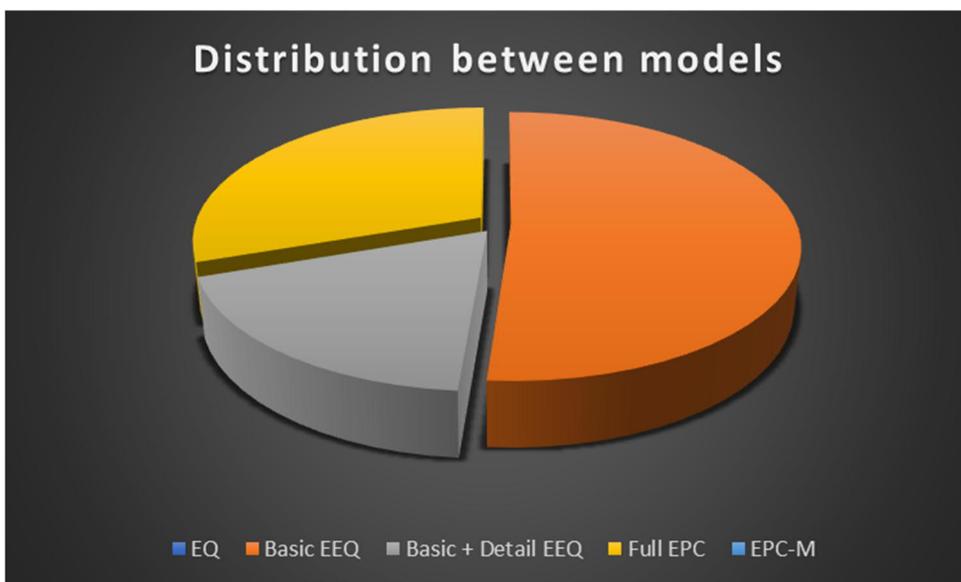
The number of projects ranged from three to fifty projects among the interviewees. Clearly, the interviewees who had mostly done EEQ deliveries have done more projects. Interviews revealed that in many cases, EPC projects are long and can, at best, last for up to more than four years. On the Marine side, on the other hand, a typical EEQ delivery takes only about three months at short. This factor explains the substantial differences between the delivery models of different projects. Totally the persons participating in the interviews have done a total of 244 projects. Out of these 125 projects belongs to the Basic EEQ delivery model,

which is the most common type of project. The second on the list was the Full EPC model for 74 projects. There were also 45 Basic + Detail EEQ projects performed by this interview group.

*“I have had fifty projects where I had been involved, and those were about 95% Basic EEQ and about 5% EPC-delivery models.”* (Interviewee, 2020)



**Chart 9.** Interview Amount of projects chart



**Chart 10.** Distribution of project delivery models according to interviewees

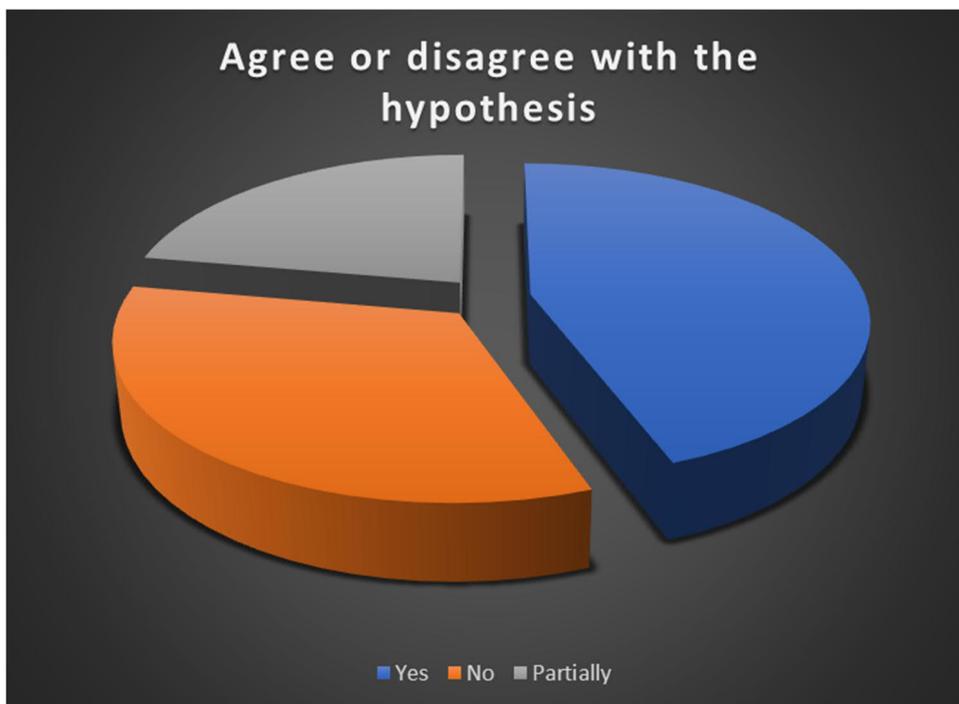
### Question 3.

Do you agree or disagree with the hypothesis, and why?

Examining the hypothesis was more challenging. The decision whether to agree or disagree was divided between the interviewees, and some of the interviewees considered it wiser to be partly in agreement and partly in disagreement with the hypothesis. After all, four agreed with the hypothesis, three opposed, and two partially agreed.

*“Holds the hypothesis true and agrees with the hypothesis. The clarity and precision of the interfaces is a challenge as Wärtsilä delivers its own project inside a larger project. In such projects, defining the contract with the necessary precision to avoid these open points mentioned in the hypothesis is very cumbersome.”* (interviewee, 2020)

*“Disagrees with the hypothesis. Even as a model of thought, the hypothesis already gives a distorted picture of project activities. The hypothesis does not fit in any way with Wärtsilä Energy’s business model.”* (Interviewee, 2020)



**Chart 11.** Interview Agree or disagree with the hypothesis.

## Question 4.

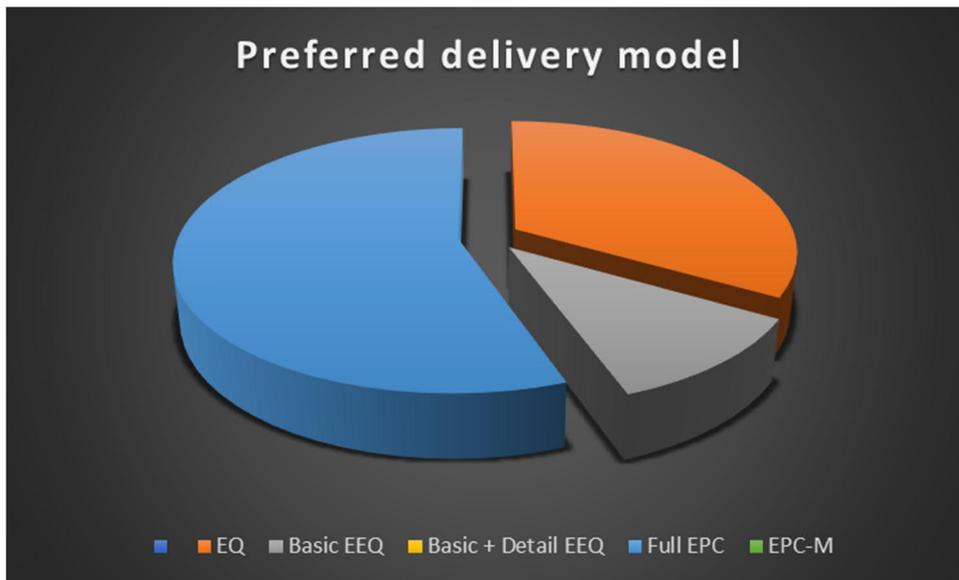
What is your preferred project delivery model, and why?

The desired delivery model for the projects followed very much the same line as the previous question. Those interviewees who agreed with the hypothesis also chose the EEQ model as their own delivery model. A few interviewees divided their thoughts and question into smaller parts and set out to think about the conditions, such as country legislation and rules, customs prosedyres, labor union regulation etc. under which the project would be carried out. It is this conditions that largely determines what a project delivery model should look like to achieve better results.

*“Mere equipment delivery, the risk-free option. Equipment deliveries are the company’s core business.”* (Interviewee, 2020)

*“EPC definitely. It has the greatest scope and the project manager has all the strings in his/hers hand and he/she is responsible for everything and is best able to control the whole project. EEQ- is more of technical implementation, and in the EPC project, the project manager does more of the project manager’s tasks.”* (Interviewee, 2020)

*“Depending largely on the implementation of the project in the country. But in some countries, definitely the EPC model and then in other countries, there is no EPC model at all. In some countries, rules, regulations, and inspections are contractually very challenging, making it very difficult to implement projects.”* (Interviewee, 2020)



**Chart 12.** Interview Preferred delivery model.

#### Question 5.

What are the most significant bottlenecks areas in the project?

When searching for project bottlenecks, the same determining factor was not found in the respondents' responses. Most of the answers to the questions went either to the design side or to the project management side, and the use of multiple different project management tools was slowing down the project. There also seems to be some conflict of interest between the different departments.

Internal quality issues were raised as one factor to slow down the projects.

The most noteworthy in the answers to this question was actually that project bottlenecks were located in the initial sector of the project timeline.

*“Ignorance of the purpose of projects can make it difficult to act.*

*Non-use of project team competence and internal resourcing. Finding support features.*

*Currently challenging and time-consuming.*

*High staff turnover and under-resourcing.*

*Internal time management, too many different systems in use.*

*Tight schedules, availability of labor.” (Interviewee, 2020)*

*“Engineering is the biggest bottleneck. The delay in engineering will delay the whole project. Another bottleneck is local installations on how to find a local workforce at a suitable price that can operate in the way Wärtsilä’s quality requires.”* (Interviewee, 2020)

Question 6.

How important do you consider the co-operation between the sales department and the project team?

On this issue, all interviewees agreed that collaboration between the project team and the sales department is essential. None of the interviewees left to deviate from this. Yet, many interviewees identified that there is much room for improvement in this area.

The interviews revealed that the problem was seen to be more prominent on the marine side than on the energy business side. Many of the interviewees stated that the project manager should be involved in the project before the contract is signed.

*“In project activities, the project manager is selected about 3-6 months before the contract is signed, after which the PM is the sales manager’s right hand, splits the project against when the first payment mail has arrived in the company’s account. The sales manager provides support with changes to the project and other similar issues. The contribution of the Chief project engineer must not be forgotten by any means, the CPE is also involved 3-6 months before the contract is signed, and there is always a guarantee that the time will expire.”* (Interviewee, 2020)

*“The question is strange because, during the sales phase, the sales team and project team should be one uniting working unit. If we want to make a profit, it has to be one unit.”* (Interviewee, 2020)

*“A critical part of a successful project is good co-operation. Good co-operation can identify crucial points and ensure that what can be delivered is sold.*

*A proper definition of interfaces and delivery content is almost impossible without the expertise of the project team.”* (Interviewee, 2020)

## Question 7.

How significant should be the project team contribution to sales projects?

The interviewees also had very similar views on the amount of project team participation. When the sales department finds that the probability of the transaction is high, then the project team must be involved very intensely. It is of primary importance that the Project Manager is involved in the conclusion of the contract in good time, then the project manager knows the deal very well, which is absolute for the success of the project.

*“At the selling stage, there are several of the most important people on the negotiating table, and it is crucial that we already have the PM on our side at this stage. In this case, we can make sure that the PM has all the necessary information for the success of the project. When the PM takes the project after the signing of the contract, he is already in principle in a worse position than the other party.”* (Interviewee, 2020)

*“Thorough co-operation from the beginning of the sales project.”* (Interviewee, 2020)

*“The project manager and the project team will make a full effort to ensure that the sales receive all the necessary information. The PM approves the schedules and makes a margin statement before G2 approval.*

*Six months before the contract is closed, the project manager must be selected in EPC projects. In EEQ projects 1-3 months before.”* (Interviewee, 2020)

*The project team helps sales define delivery content, interfaces, critical points, identify risks, and other issues that arise in collaboration with sales.* (Interviewee, 2020)

## Question 8.

Which project area consumes most of the profit margin?

In this question, the interviewees had the most perception differences, or so it seemed at first. The activities that consumed the most profit margin was mentioned: Installation and commissioning, design, Site management, pricing of services (engineering, logistics,

assembly crew, etc.), and issues related to the quality of materials. When digging deeper into the answers and by asking more specific questions, you get closer to the core of the problem. Which is? Of course, projects always come across things that have not been anticipated. Careful and precise planning could, if not altogether avoid, then at least reduce the risk of unforeseen events.

*“The installation and commissioning phase is often the most consuming because if and when the risks of the project materialize, they will have the greatest impact at this stage.”* (interviewee, 2020)

*“Planning is what we have the biggest challenge. Be it planning, procurement planning, logistics planning, or installation planning.”* (Interviewee, 2020)

*“Delays and project delays lead to additional cost increases for support functions which eat up the margin considerably.”* (Interviewee, 2020)

#### Question 9.

Do you see any similarities between the profit margin and other variables of the projects? i.e., delivery country, project scope/scale, marketing segment (oil & gas, national ownership, private ownership), economy cycles (i.e., fast build, no matter on a financial point of view)?

Almost all interviewees saw clear similarities between project variables and return margins. The similarities ranged from project management to partner awareness. At the heart of the matter in this question was largely emphasis on the inefficient practices of state-owned and large companies, which Target company has not always been able to prepare for in an appropriate manner.

Similarities between the profit margin and the variables were found for each segment, which had already been presented in the question. In addition to these, a few more were found. These new discoveries are related both to the client and to the client’s competence in project management.

*“Yes, these have a clear connection; for example, a government customer has 3-4 times longer sales cycle, but gets more out of a single project compared to the private sector. An investment in a situation like this is multiple compared to a normal situation. Typically, space-constrained ships are much more difficult to implement than weight-constrained ships.”* (Interviewee, 2020)

*“Familiar partners are more flexible than new and unknown partners. On cruise ships, working is much more difficult than on a car ferry, for example. Still, the deal has been made at the same prices.”* (Interviewee, 2020)

*“In certain segments, such as oil & gas, contracts are often made on the basis of their contracts, which immediately gives a great advantage to the customer.”* (Interviewee, 2020)

#### Question 10.

What is the main reason for the weak profit margin? (sales, EPC, unforeseen events, subcontracting, LD: s...)

There were many reasons for the poor or weak profit margin. The most interesting thing was to see that the things that were said to be the biggest reasons for the weak margin ranged from sub-area to sub-area, but still, in the big picture, they ranked in the project timeline early in the project for contract making and project management. Most of these elements, which were identified as the main reasons for the weakness of the margin, could be eliminated already at the contractual stage.

*“Lack of realistic predictability in planning and project portfolio management.”* (Interviewee, 2020)

*“Slippage from schedules eats up the most and most commonly margin in projects.”* (Interviewee, 2020)

*“It is challenging to name the same factor because all projects are individual.”*

*By cooperating well with sales, it is possible to minimize the risks of a deteriorating profit margin.” (Interviewee, 2020)*

*“A good contract is the cornerstone of a successful project, and the thoroughness of the design is another important cornerstone.” (Interviewee, 2020)*

#### Valuable remarks.

From each interview, some things were collected which were considered to be very important for the research. In this thesis they are called “Valuable remarks”. There were a lot of things in these valuable remarks that we should look at with particular precision, and so will be done in the Conclusion section of this study. Below are some selected parts from these Valuable remarks-comment:

*“A fundamental difference between the Marine and Energy Business markets. On the marine side, there are several different rating agencies and regulatory inspections that complicate and slow down the project. Power plants are designed for engines and their auxiliaries. Ships are not designed according to engines. Power plants are production-critical, i.e., the most important thing is yield/consumption. Ships are space-critical, meaning that the engine room must be as small as possible so that there is more space for the main product, whether they are passengers or cargo.” (interviewee, 2020)*

*“The Marine EPC concept is misleading because more on the marine side of our EPC operations is the subsystem EPC” (Interviewee, 2020)*

*“The difference between Basic EEQ and Basic +detail EEQ is very vain and unclear. There are possibilities for surprises in project execution.*

*What is Included and what is not.*

*Possibilities to confuse the client with different delivery models.” (Interviewee, 2020)*

*“Don’t get stuck in a mindset of no or yeah for the EPC. It is worth considering properly whether you want to offer an EPC or whether the process of an EPC would make more sense.*

*What are the right success criteria for the project?? Margin?? Customer satisfaction??”*  
(Interviewee, 2020)

#### 4.4 Lessons learned from projects

Lessons learned documentation was not available for all nine projects, it was only found for three projects. One issue with the reviewed documentation was that the official lessons learned actually remained somewhat unclear as the documentation did not go through the assumptions and main obstacles in a sufficient manner. In the end it was still unclear why the project did not succeed as planned. However, while reviewing the lessons learned, it seems that most of the problems in the projects are related to design and contract deficiencies.

## 5 ANALYSIS

This section analyzes the results from the broadest possible angle and attempts to see the results outside the box to obtain an objective perspective on the results.

### 5.1 Literature research analyses

When deciding which one of the project management systems (PRINCE2, PMP, IPMA) is the most suitable for Wärtsilä, I think everything is equally good. Every one of these gives the necessary information, and everyone also goes deeper into the project world. Owning any of these three certifications already sets you up to be better prepared for project work. The next question is, what is best for the Target company? The answer is PMI's PMP as most of Target company's employees already own this certificate. One other thing that speaks on the behalf of PMP-certificate is that it is more process-oriented than the others. The Target company's projects would benefit from a more process-driven mode, because Target company has multiple projects in many sectors, with a large organization and these types of companies will benefit from having processes implemented in their way of working.

The next question that came to mind was whether it could be mandatory for all project managers to have PMPs or some other certificate? I spent hours researching these project management models and was strong in the opinion that without such a certificate, one would not be able to cope with the work of a project manager. Apparently, all of the above is so

commercial that they had got me hooked, so to speak. I decided to take over and ask the directors of the different departments and the project managers of the old union what they think about these certificates. The answers were very similar. That is, it is always good to take such courses and achieve certificates. These provide a good starting point for project activities, but they do not guarantee that projects will be successful. Globalization has driven project work to the point that the project manager must be proficient in the following areas: Human, social, technical, and project management.

In EEQ projects, the project manager must be technology-oriented, in the EPC project, a pure project manager, and in all delivery models, social and human expert with the customer and the stakeholders.

The biggest problem I saw in this literature review is that these project management models are too rigid and resource-intensive for many of Target company's projects. Currently many of Target company's project managers have that PMP certificate and follow their instructions to the best of their ability.

While certainly, Target company would have room for improvement in project management and management systems, but I do not see that by implementing these changes in the project management department would achieve the results that is sought in this study.

## 5.2 Project profit margin result analyze

The profit margin analysis provided useful data for the investigation. Initially, we started to look purely at the outcome of the project's profit margin compared to the sales estimate and the actual one. For the industry, the comparison seemed very challenging because the margin estimated by sales could not be found from SAP but had to be retrieved from the sales calculation generated by sales. The next problem area was the change order revenues. Change orders are very common in projects and are delivered to the customer with a particular profit margin. Currently, projects are also increasing the prices (or contract value) of change orders to the SAP system, which in turn raises the project's profit margin. Thus, a pure comparison of the differences between calculated and actual costs without change orders was very challenging and even impossible.

In addition to the profit margin, this study also monitored the costs of the Main Contract. The main contract also includes other expenses observed in this work. (Power generation, common cost, project management, site management and financial and others) In many cases, when comparing the cost structure between the three factors, they were: sales estimate, project manager estimate, and last actual price. It is clear from many of the earlier charts that the actual cost is often higher than the estimate created by the sales or project department. Finding the solution to this issue from SAP is quite impossible because tracking and dedicating expense entries proved to be very challenging. In a few cases, I also asked the project controllers, but they also found it challenging to monitor.

Many times, these figures and results have only been reached after the sales calculations, lessons learned, and SAP data have been evaluated.

At times the SAP monitoring generated even more confusion than clarification.

After all, I was disappointed with the results from SAP because of their inadequacy. I was pretty sure at first that this cost analysis would find the red thread needed to do the research. However, from this review, we gained guidance on how bad the situation is and how necessary, such research is.

### 5.3 Interview analyzes

The interviews were a huge success for the research, and the interviewees were truthful and eager to share their opinions. There were nine interviewees, and the interviews took about an hour and a half per interviewee. The interviews were divided into three parts, the first of which was aimed at personal mapping qualifications. The second section focused on project delivery models and mapping the need for collaboration with the sales department, and the third section looked at issues affecting profit margins. In each interview, I also captured so-called “valuable remarks.”

From the answers to the first part, we can immediately say that all the interviewees had a long experience of working life and at Target company. The number of projects varied a lot, but keep in mind that one EPC delivery can take even two to three years for a project team,

while EEQ projects are shorter in duration. The initial questions mainly clarified the fact that all interviewees knew the delivery models used by Target company very well.

In the second part, we took a closer look and started discussing different delivery models. Here the two sets were already clearly starting to stand out. For example, when asked about the correctness of the hypothesis, nearly everyone working in the Energy Business side disagreed with the hypothesis, while the majority of those working in the Marine sector agreed with the hypothesis. A few interviewees partially agreed with the hypothesis. This was usually due to the fact that the interviewee set out to look at the matter from a bigger perspective. Those who actually agreed with the hypothesis mostly justified the fact that in the Marine sector, when EPC projects are done, there are so many interfaces and partners that the uncertainties grow so great that the success of the project becomes exponentially difficult. Then again those who disagreed with the hypothesis were of the opinion that the growth of stakeholders and access points would only require more from the agreement. In other words, the contract must be made with real precision, scope? must be determined, and the customer's responsibilities must be specified in great detail. The question rehardens the preferred delivery model, the interviewees were divided in the same way as with the hypothesis question. On the Marine side, the responses were often in behalf of the equipment delivery model, and the Energy business side preferred the EPC-delivery model.

It was interesting to note that all interviewees saw that on the Marine side it is very challenging to get projects productive because the operating environment is challenging. Finding a common bottleneck in the projects was a more challenging thing. The bottlenecks in the project were taught to be tight schedules, lack of planning, number of resourcing stakeholders, new project management processes. Clearly, there is enough room for improvement in these cases, and this research must be taken forward so that we can make these things more manageable. Clearly, many of these issues, which are perceived as bottlenecks, can be clarified when the initial planning and mapping of the project are done thoroughly.

This brings us to the following questions of the interview, which dealt with the co-operation between the project teams and the sales department. Here, everyone agreed that the

involvement of project teams already at the sales stage is crucial when it comes to the success of a project. The issue that came up very much was that the project team should be named in the EPC project about six months before signing the contract and in the EEQ projects about three months before. The question is how we can systematically involve the project team in the sales phase so that its full potential can be realized. The problem at the moment is that sometimes project groups are engaged in the sales phase, but the project team's investment in the project remains very small, which in turn leads significantly to these differences of opinion about project schedules and costs between the sales department and the project team. In other words, a summary of the co-operation between sales and projects. Co-operation must be seamless so that both parties benefit from it. Both parties have to agree to compromises, and I do not see this equation as long as departments have separate Key Performance Indicators (KPIs).

The last section of the interview focused on project finance. The area that generally consumes the most project profit margins was not entirely simple to identify from the interviews. In many cases, the interviews revealed that most of the profit margin was spent on-site activities, but when more attention was paid to the answer and the root cause of this idea, it was found that often the effects of errors at the beginning of projects are reflected in site costs. Following these considerations, planning became the most significant development. Be it cost planning, engineering planning, logistics planning, etc. It found a common denominator as the root cause of the declining profit margin.

When asked about the similarities between the profit margin and the other variables of the projects, all the interviewees at least thought that some parallels could be found. It was clearly noticeable that on the Energy Business side, more effort has been put during the sales phase to take into consideration the variables and how they affect the profit margin. On the power plant side, local contractors, local regulations, etc. had been prominent, while on the marine side, this has often not been the case on the marine side. There were cases where similar delivery content had been sold to a completely different place, and with the same monetary value.

So, what is the main reason for the low-profit margin? Like many other questions in this interview, this one shared opinions a lot. It took me a long time to analyse these answers,

and it was challenging to find a common denominator based on the answers. The best solution was given by one of the interviewees when he replied that: the common factor is difficult to name because all projects are individuals with whom different people always work. Also, the idea that came from the interviews was that the customer doesn't always understand the full scope of supply. In these cases, the Target company will often need to provide additional discounts on the missing products in order to make the equipment work as intended and keep the customer satisfied.

#### 5.4 Lessons learned analyze

This assumes that the Lessons learned document is so clearly written that a person who comes from outside the company will be able to understand what it is about and why.

In these Lessons learned documents, which were available, it was easily noticeable where one had failed, but the root cause of this often remained unclear.

## 6 DISCUSSION

What can be concluded from the results and analyzes? Well, of course, the fact that there is something wrong with the process regarding the EPC-delivery, but the most crucial question is what needs to be fixed in order to achieve a pleasant result for everyone. Clearly, it is not a question of the professionalism of the employees, as the department makes a positive result every year. Many times in a situation like this, one question arises: why even start trying EPC deliveries if you don't make them profitable? There is a clear answer or answers to this. First, it can be mentioned that it is the company's policy to provide customers with the widest possible range of different delivery models. Another issue is that if they want to keep up with the global competitive situation, they must also be able to offer EPC delivery models. There is a clear struggle between the sales and the project management department within the company, therefore in this particular study it was necessary to look at the matter from an outside perspective.

It would be important to find a business model that benefits all parties within the company. In the current situation, it is almost impossible to make projects work as efficiently as possible. The main goal should be an operating model that would be able to adapt to different projects, but still in such a way that the projects would celebrate the operating model as consistent. In order to achieve this all functions would need to be streamlined so that project work would become more efficient.

How could we ultimately evaluate the results of the study and how reliable can we consider them to be. The cost analysis carried out in the study between the projects provided reliable data on the cost distribution. A concern in this review was that it was quite impossible to ensure that the costs were categorized to the right main cost center. In a few projects, the cost differences between planned and actual were so significant that doubts about the correctness of the figures arose. Project profit margins were also significantly different from what was sold as change orders sold during the project often improved the final profit margin, which in turn does not give an accurate picture of the actual situation of the project. It is challenging to get a real picture of where individual costs have gone from the current

SAP table. The matter can probably be clarified with the project controllers as to how these costs have been distributed, but there should be an easier way. If SAP costs would always be arranged under the correct cost structure the it would be easier to locate where cost have been allocated. Currently there can be even hundreds of small cost items under a single cost structure. This might increase the workload initially, but by doing this we will be able to compare projects more quickly in the future. Also, the current way of working with change orders should be evaluated in the SAP function, so that they do not affect the overall return margin of the project.

All interviews were conducted in the same format. For the talks to be repeated in the future, both the interview questions and the entire interview presentation material have been added to this study as an appendix (Appendix 1). Although the interviews revealed a lot of different responses in some parts, they all had surprisingly similar answers. The interviewees noticed that everyone had the desire and will to develop the Target company's operations, and this immensely helped me get the most out of the interviewees. Issues were raised, such as co-operation between departments and the traceability of projects. When evaluating the interviews, the principle that the best and the weakest rating were overlooked was used. This way the research data was on a sufficiently reliable basis. There was a lot of scattering in the answers at times, but when analyzing more thoroughly some apparent similarities in the responses could be noticed. The main goals of this research (based on the research results) will below be presented chronologically from the beginning of sales to the documentation of the project Lessons learned. The conclusion section will review a single business model proposal based on a study, which have been developed. It is understandable that change takes time but it takes and requires everyone to work together to a common goal.

## 7 CONCLUSION

Based on the results compiled from the research, this section presents what according to these studies and considerations, would be the best option for the operating model of Class A EPC projects. Later, when the operating model has been developed and refined into an established operating model, a similar model could be used for other projects as well.

Value of Class A projects are more than one million euros.

When a potential business case is recognized, there is a gate model, which is the sales procedure will follow. The gates in the model are: Gate 0 (G0), Gate 1 (G1), Gate 1A (G1A), Gate 1B (G1B), and Gate 2 (G2) in figure 6.



**Figure 6.** Wärtsilä sales Gates. (Wärtsilä, Oyj, 2019)

The project manager and the project team should be involved in the project at least six months before the project reaches the Gate 2 (G2) point. It would be most optimal if the project team participated in the sales project immediately after Gate 1 (G1) approval. The rule of thumb used by the project manager and the project team is that when less than 300 hours are estimated to be spent on the project, the costs must be included in the sales budget and if more than 300 hours are spent, the department director must open a new project for sales support. For each project a so-called checklist for choosing a delivery model should be reviewed.

In Figure 7, there is one option for what would be a suitable checklist for selecting a delivery model. Before approving an index, it would be best to go through with the sales department to decide how the list should look like and what kind of delivery models shall be used. The problem that will undoubtedly arise is that the marine side should have a few other options

between the EEQ and the EPC model. One option would be a customized process EPC model. These details could be agreed upon in standard rules of the game with sales.

MARKET FACTOR	Not True at all	2	3	4. Much True
Wärtsilä has experience in the target country	B EEQ	E EEQ	P EPC	EPC
Target customer needs External financing	B EEQ	E EEQ	P EPC	EPC
Target country is a Developing country with low infra-structure	B EEQ	E EEQ	P EPC	EPC
(Food Chain ) Target country does not have developed External EPC contractor market	B EEQ	E EEQ	P EPC	EPC
(Food Chain) Target country does not have a strongly developed engineering consultancy market	B EEQ	E EEQ	P EPC	EPC
Target Country/ Customer does not have demanding local standards or special industrial requirements	B EEQ	E EEQ	P EPC	EPC
Wärtsilä has local PM and supply organisation in the target country	B EEQ	E EEQ	P EPC	EPC
Target country does not have high custom duties and strong protectionism	B EEQ	E EEQ	P EPC	EPC
Target country/customer are in a Price competitive area.				
What is customer used to buying and what is competition offering in Target country. 1 = Basic EEQ → 4- EPC (Higher number = more scope)	B EEQ	E EEQ	P EPC	EPC
B EEQ = Basic EEQ E EEQ = Extended EEQ P EPC = Process EPC EPC = EPC				

**Figure 7.** Wärtsilä scope and service. (Wärtsilä, 2010)

Once sales have reached Gate 1, it is time for one of the project delivery organization's most crucial decisions, choosing the project team members. To whom is the project suitable to award, who can cope with the project, and have enough competence for that project? The the project success criteria for the project should be made clear before the project is given to the project manager., the success criteria should contain at least the following: margin, customer satisfaction, delivery time, etc. These are the questions that need to be evaluated and one valid point that emerged from the interviews, if the EPC project is involved in complexity and high in monetary value, then it is possible to use an organization or individuals from Target company with long experience in such projects. In large projects, the work must be evenly distributed already during the sales phase, so the chances of uncertainties would be minimized as the project progresses. Here, the management keeps in mind that whenever a group of experts is formed, there is a Forming, Storming, Norming,

and Performing equation. If the chemistry of the group does not fit together, these first three parts take up much of the time, and valuable time is lost. However, the critical thing would be that the sales project would not exceed Gate 2 points until the project manager has approved the project implementation schedule and sales calculations. There is no flexibility in this principle.

Right after Gate 2, the Business development manager and the project manager jointly make a margin statement for the project management of the department. Even when the sales part of the project ends at Gate 2, it would be beneficial that the same salespersons would handle all the additional sales of the project, i.e., change orders. This would dramatically facilitate the work of the project team and provides the customer with a familiar and secure interface for new sales.

Risk management is a big part of project activities, and the primary responsibility in project activities always lies with the project manager. Projects should involve a risk engineer who is responsible for maintaining risk management in the projects. The risk engineer collects, preserves, and updates the risk list and reports it directly to the project manager. A risk engineer can handle multiple tasks simultaneously, and the project delivery model doesn't matter here. Project risks must be managed regardless of the project delivery model. The benefits of a risk engineer would be reflected in the fact that there would be a uniform practice in all projects, regardless of the delivery model. The risk engineer would make a list of risks and provide a one-month risk heat map to project and department management at certain intervals, showing the current situation of project risks. Figure 8 is a kind of heat map where you can see the most significant risks of a company project and their development from the previous meeting. Threats are marked in the heat folder, and arrows indicate the direction of risk development.

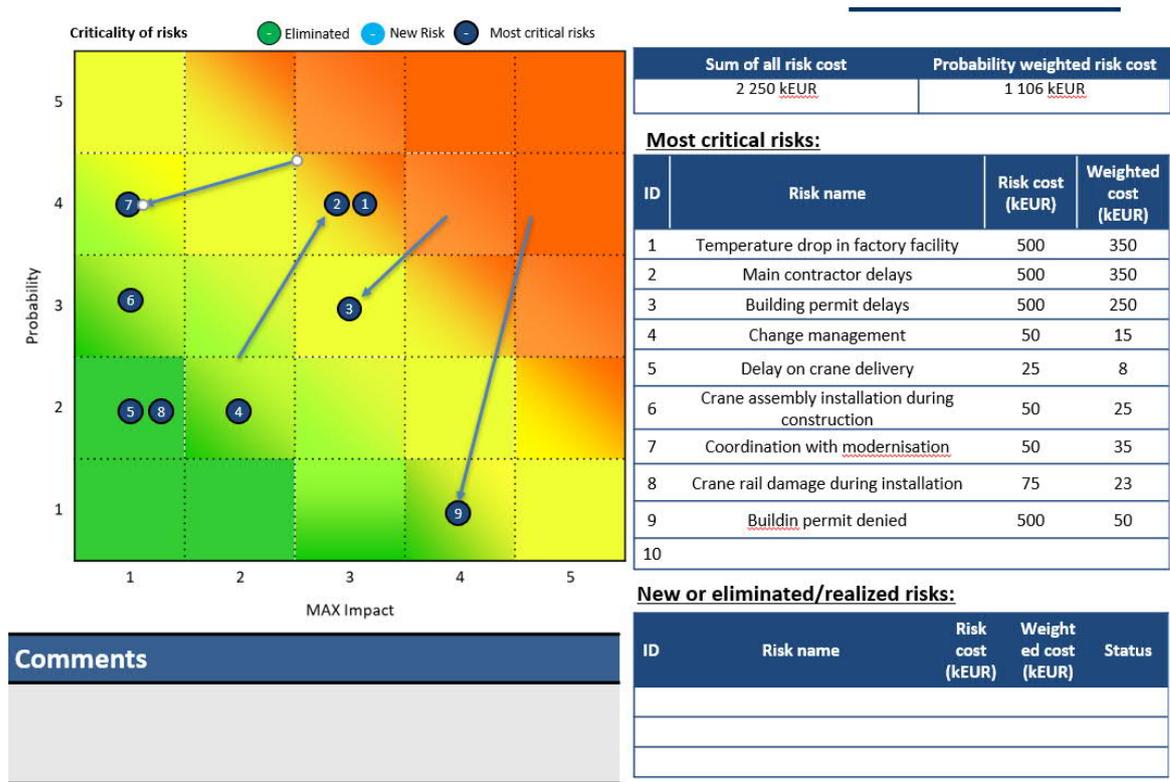


Figure 8. Risk management heat map

The next change to the current operating model would be a change in SAP transactions. A Transaction must be created in such a way that all the costs incurred in the project are marked under the head cost so precisely that it can later be determined precisely what the costs consisted of later on. For example, under site management, you will find the cost of accommodation with receipts. This would not seem to be difficult, as this is the case in Energy Business. Such a function in SAP dramatically facilitates the monitoring of the project and, later, the comparison of projects with each other. Cost tracking with this kind of structure is also beneficial for sales, as it makes it easier for them to check, for example the prices of accommodation costs in specific locations where there may be potential customers or projects.

The internal operation of the project itself does not need to be changed from the current to anything. The only thing to consider is resourcing. Depending on the scope of the project, the right kind of resources to use for the project must be assessed and determined. If several

people are involved in the project, then all of them must have clear responsibilities to avoid duplication of work.

Currently, some project managers use a project management system called Asana, which can assign project tasks to specific people involved in a project. Figure 9 is an excerpt from the Asana project management program with purchase orders and notifications assigned to an engineer in an EEQ project. Such a similar to-do list should be created for each project to facilitate project work within the team.

Task name	Assignee	Due date
▼ Purchase orders and notifications		
Site audit (External cabling / Unic) PO no. / Notification no. XXXXX		
Unic-C2 Materials from (Vendor)/ PO no. XXXXXX	Henri Tuomi...	
Unic-C2 Materials from Kamper/ PO no. XXXXXX	Henri Tuomi...	
Power Units/ PO no. XXXX		
Ethernet communication box/ PO no. XXXX		
Plant MCM load sharing box/ PO no. XXXX		
SAP Cost element number for electrical design (Network_Activity No)	Henri Tuomi...	
Unic Software creation by Technical Services/ Notification no. XXXXXXX	Henri Tuomi...	Sep 5, 2021
O&M and SPC Notification / PO no. XXXXXXX	Henri Tuomi...	Sep 5, 2021
Unic Superintendent/ Notification no. XXXXXXX	Henri Tuomi...	
Unic Installation team/ PO no. XXXXX	Henri Tuomi...	

**Figure 9.** Asana project management tool

When the project is so far advanced that a construction site is started, then there must be a communication plan, fully prepared. Based on research findings and good practice, preparing a weekly progress report at the beginning, a more extensive monthly report, and a daily follow-up report at the start of implementation. Whenever there are delays at the site, the project team must be notified immediately so that the project team is aware of the reasons for the delays.

When the project is complete, it's time to collect lessons learned. This document has many uses, but its primary purpose is to provide the most important information about that particular project. No project goes smoothly, and unknown factors always come up in large projects, which are easy to detect afterward. For such events, it is of utmost importance to collect the lessons learned documenting correctly. A lessons learned template could be made which can assist project managers to include all needed information about the project. Although the project manager is responsible for everything, this report needs input

from all project team members. The documentation should be structured so that it has 1. Category, i.e., which part of the area the matter belongs to (sales, project management, logistic, documentation, site works, warranty, etc.). Then 2. Issue (i.e., more specific name for the topic), 3. Problem/success (detailed description of the event.) 4. Impact (how it affected the project) 5. Recommendation (recommendations on how to avoid a similar adverse event or vice versa how to get more successful events.).

Currently, the sales department KPI is - Net sales, - Order intake, and margin.

None of these tell how well sales have been able to take into account all the variables of the project, this model would introduce a KPI (in addition to the present ones) that would measure the Sales Profit Margin against the actual profit margin of the project. This KPI should be a common factor between the project team and sales. Since both have already made a joint contribution to the Gate 2 sales budget, both must have an interest in improving their profit margins. This approach will harmonize the practice of EPC delivery models and make project management easier.

## 8 SWOT ANALYSIS FROM CONCLUSION

SWOT analysis is often used in companies when evaluating a strategy. The strength of the research is that it forces us to look at the process and approach in this study from four perspectives: Strengths, Weaknesses, Opportunities, Threats.

### 8.1 Strengths

- We have excellent knowledge of our products and practices.
- It is possible to combine two essential functions to improve the result.
- A better and longer contact interface with the customer.
- Ability to compare projects better.
- We are improving resourcing.
- Transparency of projects.

### 8.2 Weaknesses

- A big organization, slow changes.
- Too few similar EPC projects.
- Greater the project greater the risks.
- Big projects more unforeseen events.

### 8.3 Opportunities

- New task/job opportunities within Target company.
- Projects are more comfortable to complete.
- Dare to take on more significant EPC projects.
- Customized solutions for customers.
- Revamped delivery model.
- Business growth.

### 8.4 Threats

- People do not want to merge with a new way of work.

- Suppliers price variation on goods.
- Increased costs during the sales phase.
- The higher workload causes unhappiness.

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APPENDIX I, 1 Interview presentation material



## HENRI TUOMINEN



- Born: 15.3.1981, Turku
- Education:
  - 1999 fine mechanic
  - 2009 specialist vocational qualification
  - 2013 B.Sc. in Machine tech.
  - 202? M.Sc. in Machine tech.
- Career:
  - 1999-2002 Welder, TPA-group
  - 2002-2008 Welder, YIT-~~Industria~~
  - 2008-2013 Welder/Steam specialist, Neste Oil
  - 2013-2019 Superintendent Engineer, Wärtsilä Field service, (ES)
  - 2019-2020 Project Manager commissioning Meyer Turku,
  - 2020→ Chief Project Engineer (Prohoc) Wärtsilä Marine Asset Management Services.



## PURPOSE OF THE THESIS



- Proposal for EPC-bussiness model
- Proposal for a large EPC-delivery
- Best practices for EPC-delivery

## PURPOSE OF INTERVIEW

- Interviews are most effective for qualitative research method
- To get more thorough understanding about project delivery models
- To get multiple point of views on different project
- To Find similarities between constraints in different projects
- To get Information to avoid fox-holes in future projects
- To give important inputs to finalize the Master thesis

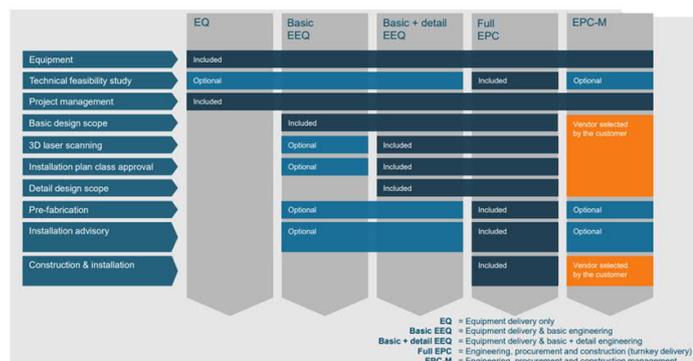
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# QUESTIONS

- Divided in three (3) parts. Total of ten (10) questions
  - Part 1 Background ( two questions)
  - Part 2 Delivery Project models ( Five questions)
  - Part 3 Project Financial ( three questions)
- Interview will be recorded if agreed.
  - The answers to the interview will be written clean and sent to the interviewee for approval. After approval, the recording is destroyed.

## PART 1 BACKGROUND

- Occupation and work experience
- Approximate number of projects, and how they are distributed between different delivery models?



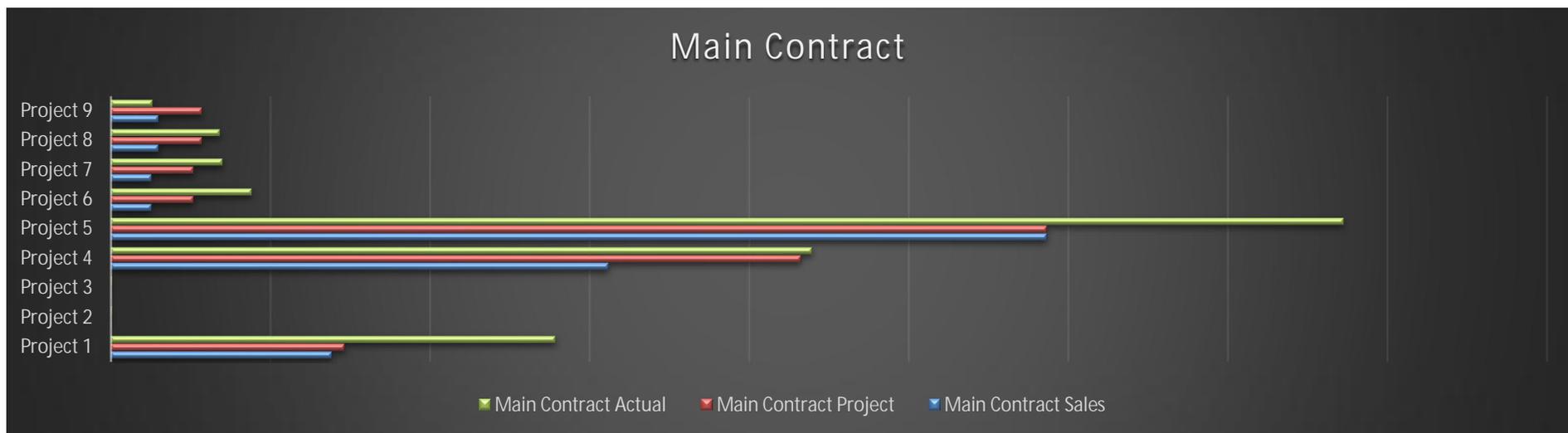
## PART 2 PROJECT DELIVERY MODEL

- Hypothesis:  
*EPC delivery is almost impossible to make it profitable in a service business without leaving open-end items. The best way to enlarge scopes is to select specific activities that can be sold along with equipment. Corresponding competences should be in house or from close partners. This should be clearly specified in the sales phase.*
  - Do you agree or disagree with the hypothesis, and why?
  - What is your preferred project delivery model and why?
  - What are the biggest bottlenecks areas in the project?
  - How important do you consider the cooperation between the sales department and the project team?
  - How big should be the project teams contribution to sales projects?

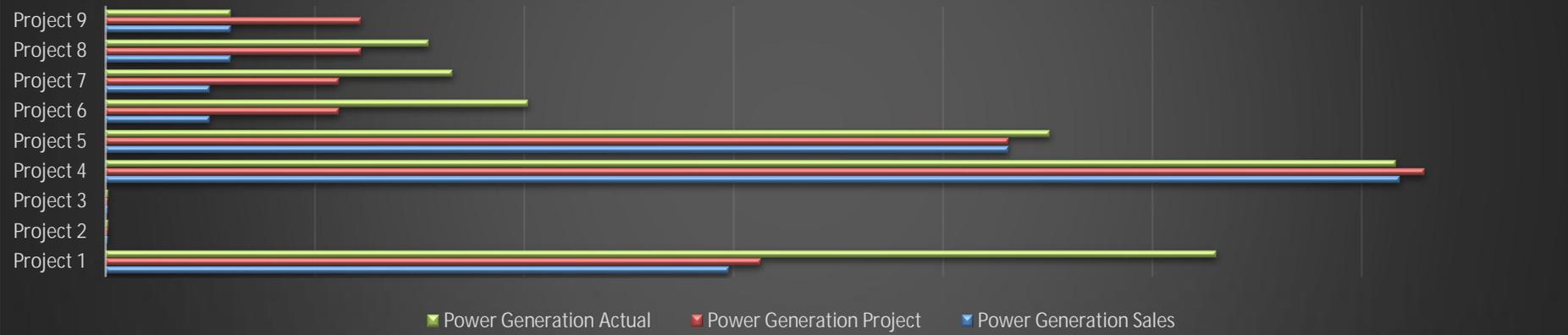
## PART 3 PROJECT FINANCIAL

- Which project area consumes most of the profit margin and why?
  - Engineering, procurement, logistics, documentation, project management, Site management, warranty, etc
- Do you see any similarities between the profit margin and other variables of the projects?  
i.e. delivery country, project scope/scale, marketing segment (oil & gas, national ownership, private ownership), economy cycles (i.e. fast build, no matter on financial point of view)
- What is the main reason for weak profit margin? (sales, EPC, unforeseen events, subcontracting, LD:s...)?

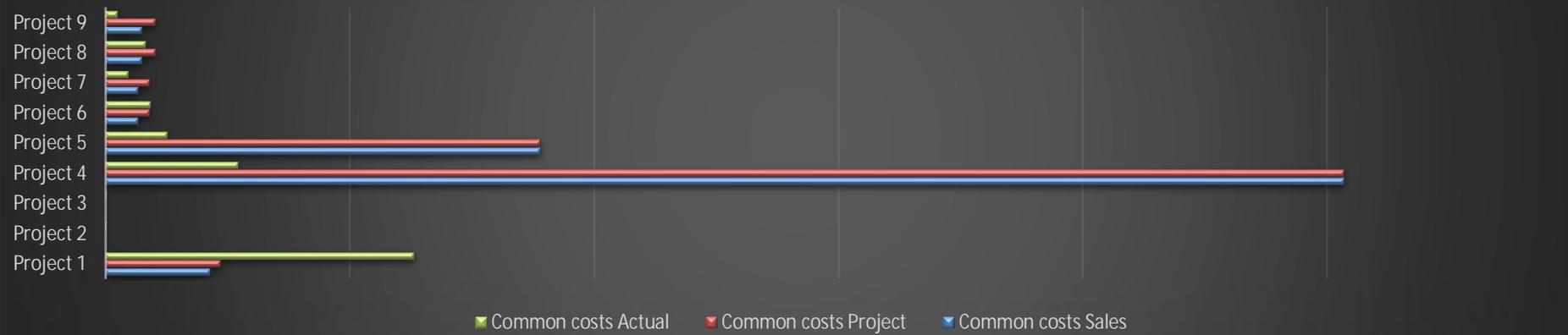




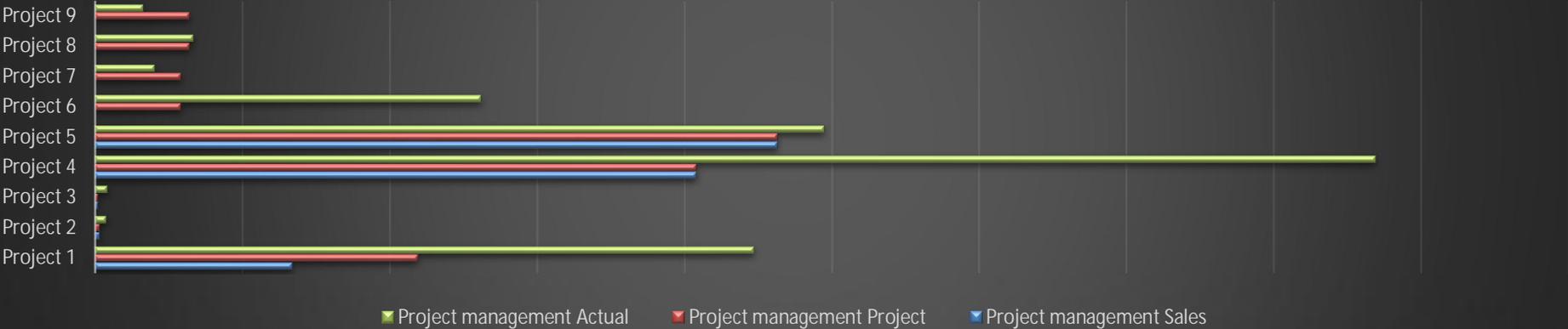
## Power Generation



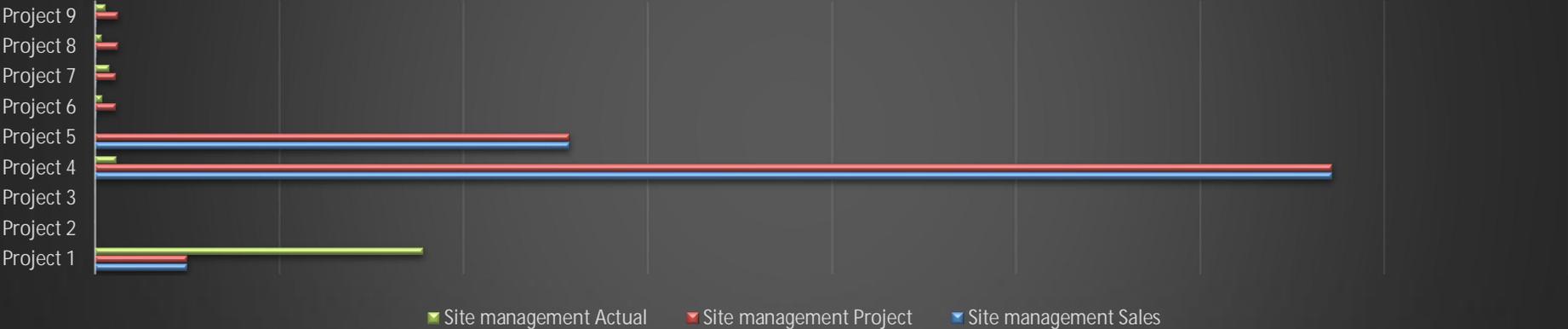
## Common costs



### Project management



### Site Management



# Financial



Financial Actual Financial Project Financial Sales