

Analysis of Power Plant Logistics and Site Management Cost Estimation

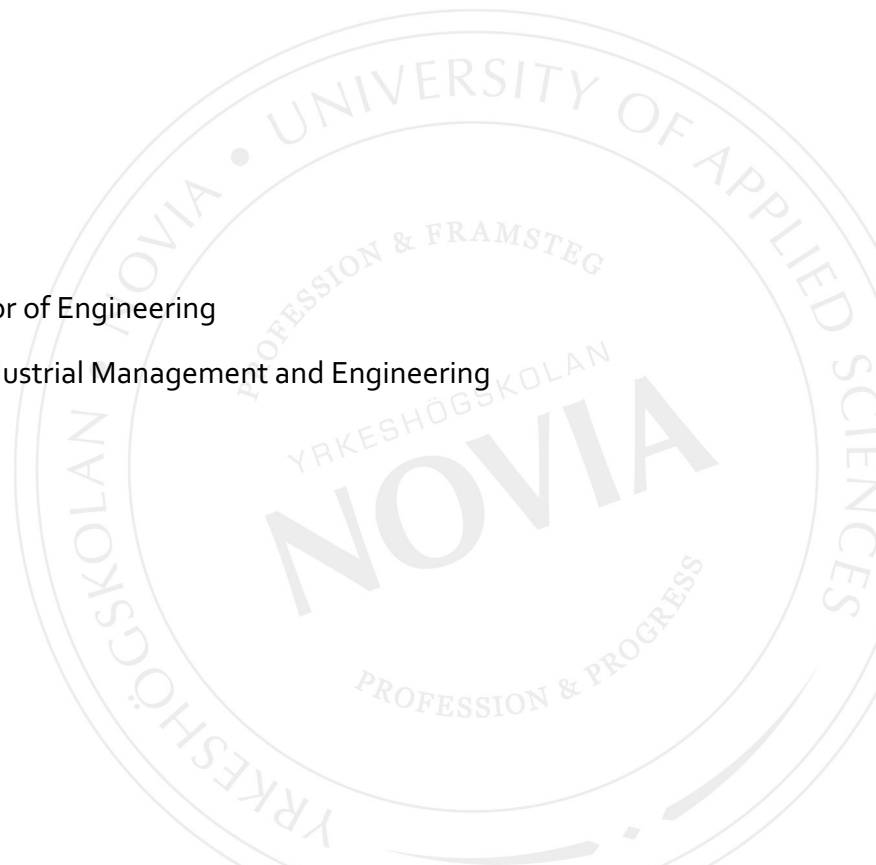
Case: Wärtsilä Energy Business

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Degree Thesis for Bachelor of Engineering

Degree Programme in Industrial Management and Engineering

Vasa 2019



BACHELOR'S THESIS

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Title: Analysis of Power Plant Logistics and Site Management Cost Estimation

Date 11.4.2019 Number of pages 23

Appendices

Abstract

This thesis is written for Wärtsilä Energy Business, Project Management Development & Tools department. The objective of this thesis was to analyze how accurate Wärtsilä has been when estimating costs for Power Plant Logistics and Site Management. The purpose was to suggest improvements on the cost estimation process and the cost estimation tool in CRM.

Execution of this thesis was conducted in two different steps. Initially, historical data from projects were collected and analyzed to understand how accurate cost estimation has been in the past. The data consisted of Sales Budget and Actual Costs. Secondly, interviews were conducted to gather expertise advice and to discuss what could be improved.

Result of this thesis include improvement suggestions on cost estimation tool and process as well as other relevant findings which have occurred during the execution of this thesis.

Language: English
estimation

Key words: Analysis, data, logistics, management, cost

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EXAMENSARBETE

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Titel: Analys av Logistik och Arbetsplatslednings kostnads estimering

Datum 11.4.2019 Sidantal 23 Bilagor

Abstrakt

Detta examensarbete är gjort på uppdrag av Project Management Development & Tools avdelningen inom Wärtsilä Energy Business. Syftet med detta examensarbete var att analysera hur väl Wärtsilä har budgeterat kostnader för Logistik samt Arbetsplatsledningens kostnader för projekt. Målet var att hitta förbättringsförslag för budgeteringsprocessen samt kostnadsberäkningsverktyget i CRM.

Utförandet av detta examensarbete gjordes i två steg. Inledningsvis jämfördes data från historiska projekt för att få en överblick hur väl kostnader har blivit budgeterade jämfört med ackumulerade kostnader för projekten. Andra delen av utförandet innehöll intervjuer för att få en bättre bild hur kostnader blir budgeterade, vilka svårigheter som finns samt vad som kan förbättras i kostnadsberäkningsverktyget och budgeteringsprocessen.

Resultatet från detta examensarbete är förbättringsförslag på kostnadsberäkningsverktyget samt budgeteringsprocessen. Även andra relevanta upptäckter har gjorts under utförandet av detta examensarbete.

Språk: Engelska
analys

Nyckelord: Kostnadberäkning, budgetering, logistik, ledning, data,

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Päivämäärä 11.4.2019 Sivumäärä 23 Liitteet

Tiivistelmä

Tämä Opinnäytetyö on tehty Wärtsilän Energy Business, Project Management Development & Tools-osastolle. Opinnäytetyön tavoitteena oli analysoida, kuinka tarkka Wärtsilä on ollut arvioidessaan Power Plant logistiikan ja työmaajohdon kustannuksia. Tarkoituksena oli ehdottaa parannuksia kustannusarvioprosessiin ja kustannusarviotyökaluun CRM:ssä.

Tämän opinnäytetyön toteuttaminen toteutettiin kahdessa eri vaiheessa. Aluksi kerättiin ja analysoitiin projektien historiallisia tietoja, jotta saisi parempi tieto, miten tarkka kustannus arvio on ollut menneisyydessä. Tiedot koostuivat myyntibudjetista ja todellisista kustannuksista. Toiseksi on käyty haastatteluja asiantuntijalausuntojen keräämiseksi ja siitä, mitä voitaisiin parantaa.

Tämän opinnäytetyön tulos sisältää parannusehdotuksia kustannusarviotyökaluun ja -prosessiin sekä muita merkityksellisiä havaintoja, jotka ovat kertyneet tämän opinnäytetyön toteuttamisen aikana.

Kieli: Englanti
tiedot, analyysi

Avainsanat: Kustannusarvio, budjetti, logistiikkaa, johtaminen,

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TERMS AND ABBREVIATIONS

WEB	Wärtsilä Energy Business
CD Projects	Customer Delivery Projects
EPC	Engineering, Procurement and Construction
Process EPC	EPC above floor level
EEQ	Engineered Equipment Delivery
Basic EEQ logistics)	Basic Engineering, procurement (equipment delivery,
Extended EEQ	Detailed Engineering, procurement (equipment and material delivery, logistics)
ED	Equipment delivery
CFU	Cost Follow Up
WBS	Work Breakdown Structure
PMDT	Project Management Development & Tools
EDW	Enterprise Data Warehouse
SAP	Enterprise Resource Program
CA PPM	Enterprise Resource Program
CRM	Customer-Relationship Management

FOREWORD

I would like to extend my deepest gratitude to Wärtsilä for providing me with the opportunity to write my Bachelor's Thesis for the company. I would also like to extend my deepest gratitude for the people who have participated in helping me achieve the result of this thesis. Lastly a special thanks to Mats Bystedt and Jonatan Sandvik for supporting and helping me during this process.

Also, a huge thanks to Roger Nylund and Novia UAS for the support and supervision in writing my thesis.

1 INTRODUCTION

This chapter presents an overview of the thesis, including the problem area and purpose behind the thesis. Followed by this, delimitations and confidentiality will shortly be discussed. At the end of this chapter an overall disposition will be presented, to give a better understanding of the composition of the thesis.

1.1 Background

Custom-made solutions are expected more and more from the customer in the market today. Thus, sellers must become more flexible in their ways of adjusting the business depending on what the customer demands. This leads to a trend where companies are shifting from product-based to project-based companies. Being a project-based company has a lot of advantages. However, project-based companies also face a lot of challenges.

The study is made for Project Management Development & Tools (PMDT) – Wärtsilä Energy Business. The Project Management Development & Tools department's responsibilities are described more in depth in Chapter 2.3.

Estimating costs for a whole project can be very difficult. Wärtsilä Energy Business sells power plants tailored to the customers and builds them all over the world, this means that every project is unique and cost estimation is tailored for each project. Project definition is described more in depth in Chapter 3.2.

CRM, an estimation-tool to estimate costs has been created to streamline the process of creating a budget for a project, however the estimation tool does not include all aspects of the logistic process and is not applicable for all types of projects. This thesis will also include how costs are estimated for Site Management, and if there are improvements to be utilized.

1.2 Problem Area

Making good cost estimations is one of the keys for a company to be able to accumulate profit and survive. Cost estimation tools and way of working need to be up to date, improved and results need to be followed-up in order for the company to optimize their potential.

The term underpricing means that project generates lower profit than expected and, in some cases, even losses, however overpricing can also be hurtful for a company's net sales and profits. Over pricing can make the company less competitive on the market and this can lead to possible losses of sales.

1.3 Purpose

The purpose of this thesis is to analyze how accurately Wärtsilä Energy Business estimates costs for Power Plant Logistics and Site Management, costs for the whole segment. This will be done by checking how accurately costs are estimated for Customer Delivery projects by analyzing historical data and theory. Furthermore, the aim is to suggest improvements on the estimating process and estimating tools.

1.4 Delimitations

Wärtsilä Energy Business have through the years delivered a wide range of diverse types of projects within the energy market. This thesis will only consider customer delivery power plant project. Basic EEQ (engineered equipment delivery), Extended EEQ, EPC (engineering, procurement and construction) and Process EPC scope types. This thesis will not take into consideration Nuclear, LNG and container projects.

The thesis analyses the whole Work Breakdown Structure, to get a broad understanding of what the WBS contains and how costs are accumulated from different activities. WBS is described more in depth in chapter 3.5.3.

The thesis does not consider if singular events have occurred which have led to unexpected costs and therefore have higher actual costs than initially estimated. The aim is only to analyze how large the deviation is between sales budget and actual costs and to suggest improvements in budgeting phase.

1.5 Confidentiality

This thesis handles sensitive internal information and can be studied freely within Wärtsilä but cannot be shared outside of Wärtsilä.

1.6 Disposition

The first chapter gives the reader an introduction to the background, problem area and the purpose behind the theses. Delimitations and confidentiality are also presented.

The second chapter presents the company and its organizations in brief. Project Management Development & Tools department is also presented.

The third chapter contains the theoretical structure relevant to the thesis. This chapter will help the reader to get a basic knowledge of the subject.

The fourth chapter consists a conclusion where the result is discussed, and further research is proposed.

2 WÄRTSILÄ IN BRIEF

Wärtsilä's history is long, the company was established in 1834. Wärtsilä started as a small sawmill and is today a global leader in smart technologies and complete lifecycle solutions for the marine and energy markets. Wärtsilä operates in more than 80 countries and has approximately 19 000 employees in more than 80 countries. Wärtsilä reached a total net sale of 5 174 million EUR in 2018. (Wärtsilä, 2018a)

Wärtsilä's purpose is to enable sustainable societies with smart technologies, by emphasizing these key words Wärtsilä can maximize power plants and vessels environmental and economic performance for the customer.

Wärtsilä will achieve its purpose by establishing and maintaining strong presence in key growth market, continuing to ensure that offerings delivers best value to customer, transforming the company to a smart technology and redefining the brand, communications and marketing to deliver the purpose. (Wärtsilä, 2018b)

As of 2019 Wärtsilä is divided in to two business segments instead of three. The new setup is Energy Business and Marine Business. Services which has formerly been a separate segment is now integrated into the two new areas of business. Service portfolio consists of spare parts, optimizing services and maintenance. Services have globally around 4500 professionals who are stationed around the globe to help the customer when needed. (Wärtsilä, 2018e)

Wärtsilä's purpose and strategy are presented in Figure 1.



Figure 1 Wärtsilä's purpose & strategy

2.1 Marine Business

Marine market is the main focus in Marine Business department, Marine Business have for a long time been in a strong position in the market providing ship machinery, propulsion and manoeuvring solutions. According to Wärtsilä, every 3rd ship in the world is maneuvered by a solution from Wärtsilä Marine Business, this indicates the strong position in the market. Wärtsilä Marine Business operates all the main vessel segments with a very broad portfolio of products, solutions and services.

Environmental friendly solutions are changing the market and Wärtsilä is responding to the change with their newest engine, the W31 which is the record holding world's most efficient 4 stroke diesel engine. (Wärtsilä, 2018c)

2.2 Energy Business

Wärtsilä Energy Business is the business segment that focuses on designing and building power plants. The customers for this business area are industries, independent power producers and utilities. Wärtsilä Energy Business is the leading EPC contractor and lifecycle support provider. The portfolio of solutions is very broad, and it contains ultra-flexible internal combustion engine-based power plants, energy storage systems, utility-scaled solar photovoltaic power plants and LNG terminals and distribution systems. Wärtsilä Energy Business is working towards a 100% renewable energy future. (Wärtsilä, 2018d)

2.3 Project Management Development & Tools

Project Management Development and Tools department's main responsibilities consists of developing and deploying project management processes and supporting tools. These processes and tools are distributed to all areas and business lines within WEB. The tools and processes provided by PMDT are monitored and controlled that they are used correctly and consistently. Beyond this PMDT also provide input to different departments.

3 THEORY

This chapter will present the theory which supports this thesis. The theory will help to get a better understanding of the problem, the method and the results. The chapter will firstly explain the theory regarding the research method and data. Thereafter the process of projects, Logistic and Site Management within Wärtsilä Energy Business will be compared to general theory. Finally, the cost estimation will be discussed.

3.1 Research methods & data

The information needed from a research decides which method of research is most applicable. Most research methods yield data in some shape or form. The data then needs to be interpreted. This chapter will further explain both Qualitative research and Quantitative research. Lastly, data is further explained.

3.1.1 Qualitative research

The process of qualitative research refers to the process where the researcher conducts research where the data is systematically examined and arranged. The data consists of interview transcripts, field notes and other sorts of material. The goal with this kind of research is to achieve a result based on the data collected. To achieve this goal the researcher actively analyses the data, breaking it down, arranges it and looks for patterns in the data. (Korutizin;Piquemal;& Norman, 2009)

However, this kind of research can be very challenging since there's usually a lot of data to make sense of. The researcher must identify significant and meaningful patterns. When it comes to rules regarding qualitative research almost none can be found other than using intellect and represent the data according to the purpose of the study. (Bodgan & Biklen, 2007)

The Zacharias Group (2019) defines the qualitative research method process to be divided in to eight stages as presented in Figure 2. Initially the objective of the research needs to be

defined, followed by determining focus groups, ways of working and other relevant information which have the purpose of achieving the desired result. After the research has been conducted, gathered information needs to be firstly analyzed and finally an action plan needs to be developed for the research to fulfil its purpose.

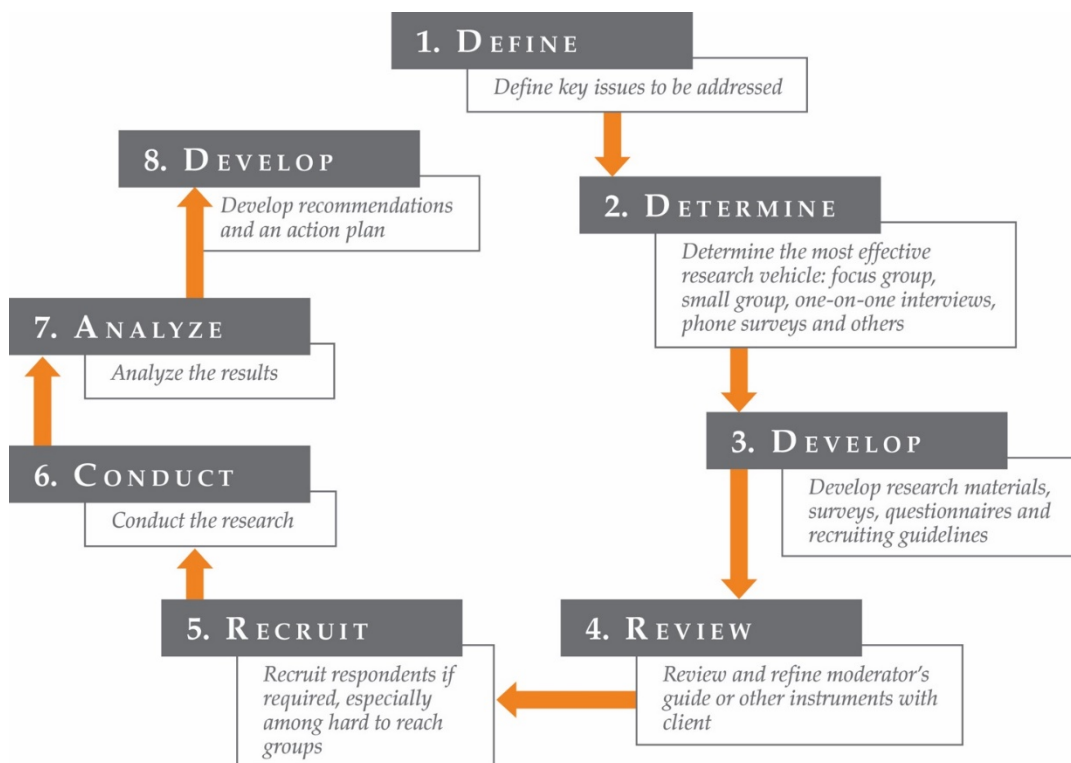


Figure 2 Qualitative research process according to the Zacharias Group (2019)

3.1.2 Quantitative research

The opposite to qualitative research is quantitative research and this form of research refers to the method of gathering data in a numerical form which can be categorized, ranked in order or measured in units. The data obtained by this form of research method can be used to construct graphs and tables. Methods to obtain data through quantitative research are experiments, surveys and questionnaires. Pre-existing data can also be used and analyzed. This form often yields data that can be measured in some shape or form. (McLeod, 2017)

According to Bhat (2019) there are four major advantages of quantitative research:

- 1) *“Reliable and accurate data”*: The data is collected, analyzed and presented in numbers. This is then presented, and the results obtained will be very reliable.
- 2) *“Quick data collection”*: A group of people also called a population is the target when conducting a quantitative research. This means that the research method yields efficiently.
- 3) *“Wider scope of data analysis”*: This method provides a wide scope of data collection
- 4) *“Eliminate bias”*: In other words, no individual comments are taken into consideration in the result.

According to Bhat (2019) there are three diverse methods of quantitative research which are presented in Figure 3. Survey research refers to the method where data is collected by asking questions in a survey. Pros of a survey research is that it is easy to reach out to a bigger population of correspondents. Correlation research refers to the method where variables are measured to assess the statistical relationship. Lastly, experimental research refers to the method of using variables which can be controlled and manipulated to check what the outcome is.



Figure 3 Quantitative research according to Bhat (2019)

3.1.3 Data

Data is the term which refers to the research-material that has been gathered by the researcher during the study, this data includes material such as numerical data, statistics, interview transcripts and other documents which build the foundation of the study. This data needs to be analyzed and interpreted in order for the data to yield value. (Bodgan & Biklen, 2007)

Analysis is the term which describes the process of compiling the collected data, sorting and organizing it to categories, patterns and descriptive units. Interpretation refers to attaching an understanding and significance to the analysis. It also includes explaining patterns and searching for connections in the data. (Silverman, 2011)

3.2 Project definition & Projects within Wärtsilä Energy Business

A project is defined as being a temporary endeavour with the purpose of creating a unique product, service or result. Temporary indicates that a project has a definite beginning and end. When the objective of the project has been reached, the project has reached its end. However, a project can also be terminated if the client who is defined by being a customer, sponsor or champion wishes to terminate the project. Unique is the keyword and it refers to that projects bring risks and are often more or less unfamiliar. (PMBOK®, 2013)

3.2.1 Project types and classes within Wärtsilä Energy Business

There are three categories of projects within Wärtsilä; **CD** (Customer Delivery), **PSD** (Product and Solution Development) and **OD** (Operational Development). Each category of projects has a couple of project types which indicates the nature of the project, this thesis will only cover the main Wärtsilä Energy Solution Customer Delivery project types which are presented in Table 1. (Wärtsilä, 2017b)

Project Type	Description
EPC	Engineering, procurement, construction
Process EPC	EPC above floor level
Basic EEQ	Basic engineering, procurement (equipment delivery, logistics)
Extended EEQ	Detailed engineering, procurement (equipment and material delivery, logistics)

Table 1: CD project types

EPC is the project type where Wärtsilä is responsible for all aspects of the work, which includes engineering, procurement, construction and installation. Since only one contractor is needed in EPC projects, customer sees this as an advantage. Process EPC differs from EPC because Process EPC refers to installations above floor level, this means that site area works, subsoil, foundation works, and supply of underground material are not included.

Extended EEQ and Basic EEQ are defined as equipment delivery projects. Extended EEQ refers to projects where a complete supply solution which includes detailed engineering and all the materials and equipment needed for a power generation is delivered, also includes the main building and related equipment. Basic EEQ refers to projects where the main equipment with related auxiliaries, process equipment and materials are engineered and delivered. In this type of project, customer is responsible for own resources such as management, construction, installation and detailed engineering

These project types are also divided into classifications depending on the complexity of the project, the classification can change during the planning phase of the project when more information has been gathered. The target of the classifications is to ensure that the right level of project management is allocated to the project. There are three project classifications; A is a very complex project, B is a normal project and C is a simple or straightforward project. (Wärtsilä, 2017b)

3.2.2 Project organization & lifecycle

The general principle is that every project needs an owner with the business interest. The project owner defines goals for the project and together with the steering committee members ensures the environment for the project's success. The steering committee has two goals; Firstly, to ensure the business benefits of the project and secondly to allocate resources. The steering committee also makes the major decisions of the project regarding objectives, resources and the schedule. (Wärtsilä, 2017b)

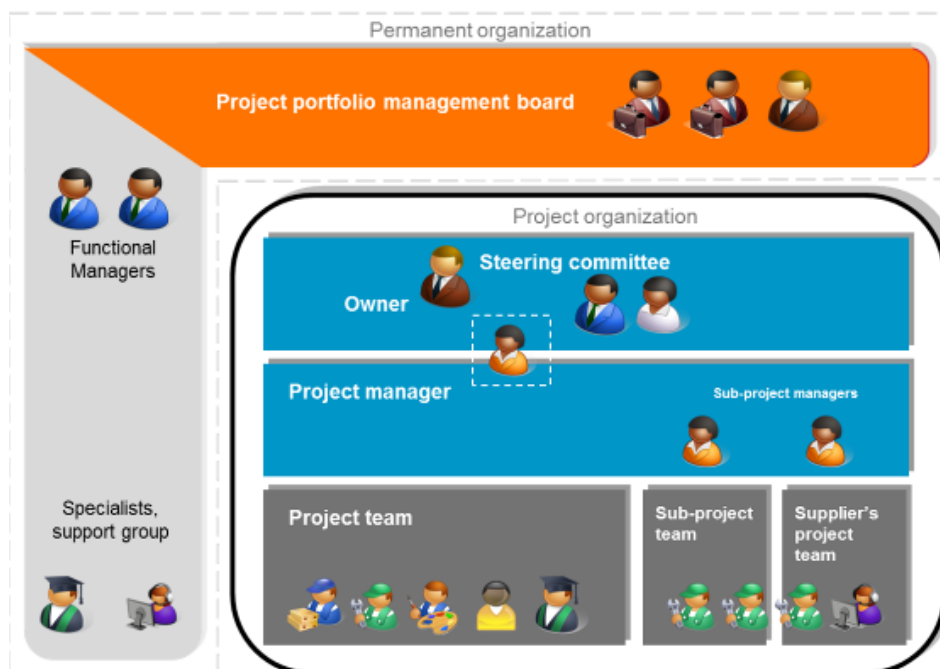


Figure 4 Project organization

Figure 4 presents the standardized project organization within Wärtsilä Energy Business.

For the operational management every project has a project manager who is accountable and liable for the project. To be able to execute the project the project manager has a project team who are responsible for the concrete project work. The project team can differ depending on the complexity and scope of the project. Resources for the project team are allocated depending on type and classification of the project. (Wärtsilä, 2017b)

In Wärtsilä Energy Business there are project phases and process groups which steers the project execution and support the implementation of the project work in order for the project to reach the desired result. The project lifecycle consists of four main phases which are:

1) Initiate

2) Plan

3) Execute

4) Close.

There are also two subsequent phases which are:

5) Explore

6) Evaluate benefits.

Lifecycle phases starts and ends with decision-making points, also called gates, which are mandatory and is a decision point if the project can be continued (GO) or if the project should be discontinued (NO GO). In addition to the gates there are “Milestones” which indicates a significant event in the project, these milestones e.g. Procurement/Logistic Kick-off, help the project’s management to monitor the progress of the project. (Wärtsilä, 2017b)

Wärtsilä has developed a Project Model Framework which is presented in figure 5.

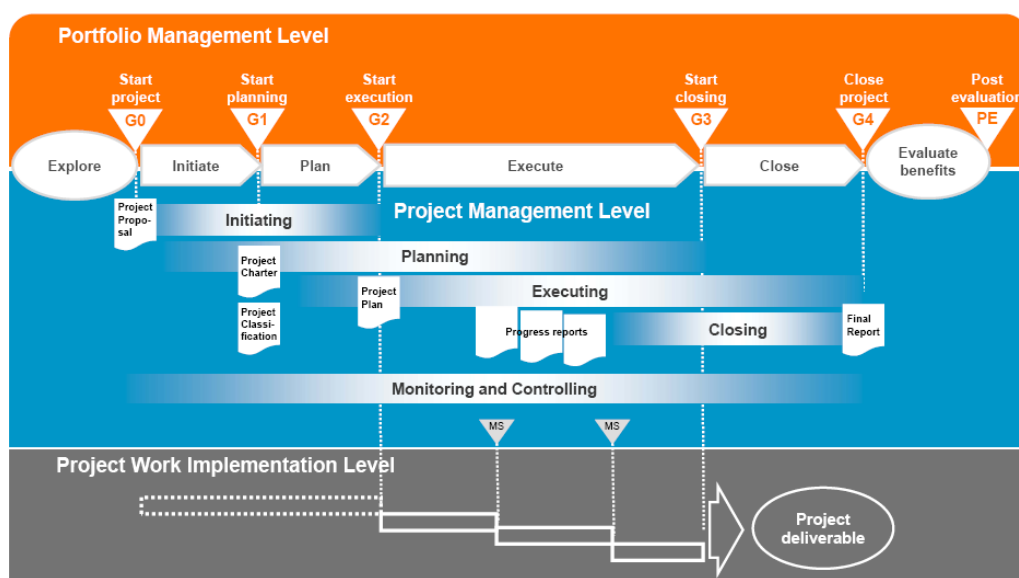


Figure 5 Wärtsilä Project Model Framework

3.3 Project Logistics

Logistics refers to the process of controlling and managing the flow of resources, such as goods, information and other. The process involves packaging, material handling, warehousing, inventory and transportation. In a broad sense, logistics also include purchase and sales, meaning that sales representatives together with purchasing representatives negotiate terms of business and price for the goods or services to be delivered. Project logistics differs from the more conventional logistics in a few different ways and is characterized by three elements:

- 1) **Converging**, meaning that all materials are gathered to the site, the facility is assembled from these materials.
- 2) **Temporary**, as earlier mentioned a project is a temporary endeavor and the logistic aspect does not differ from that, the project supply chain is temporary with the purpose to converge all material to site.
- 3) **Made-to-order**, temporary also means that supply chain and logistics for a project is “made-to-order” for each new project and there’s little repetition. (Gudehus & Kotzab, 2012)

Outsourcing logistics for a project is a way to become more cost effective and efficient. Usually a third-party company providing logistic services handle the shipping of materials to site, this can include marine or air cargo, trucking and special transportation. (Steyn & Lourens, 2018)

Costs and risk assessment for logistics are also dependent on what kind of incoterms, which are the “International Commercial Terms”, have been agreed upon. For example, if contract states that incoterms are *DAP*(Delivered at Place), Wärtsilä is responsible for all transport from being sent to being delivered at the site. Incoterms 2010 are presented in Figure 6.

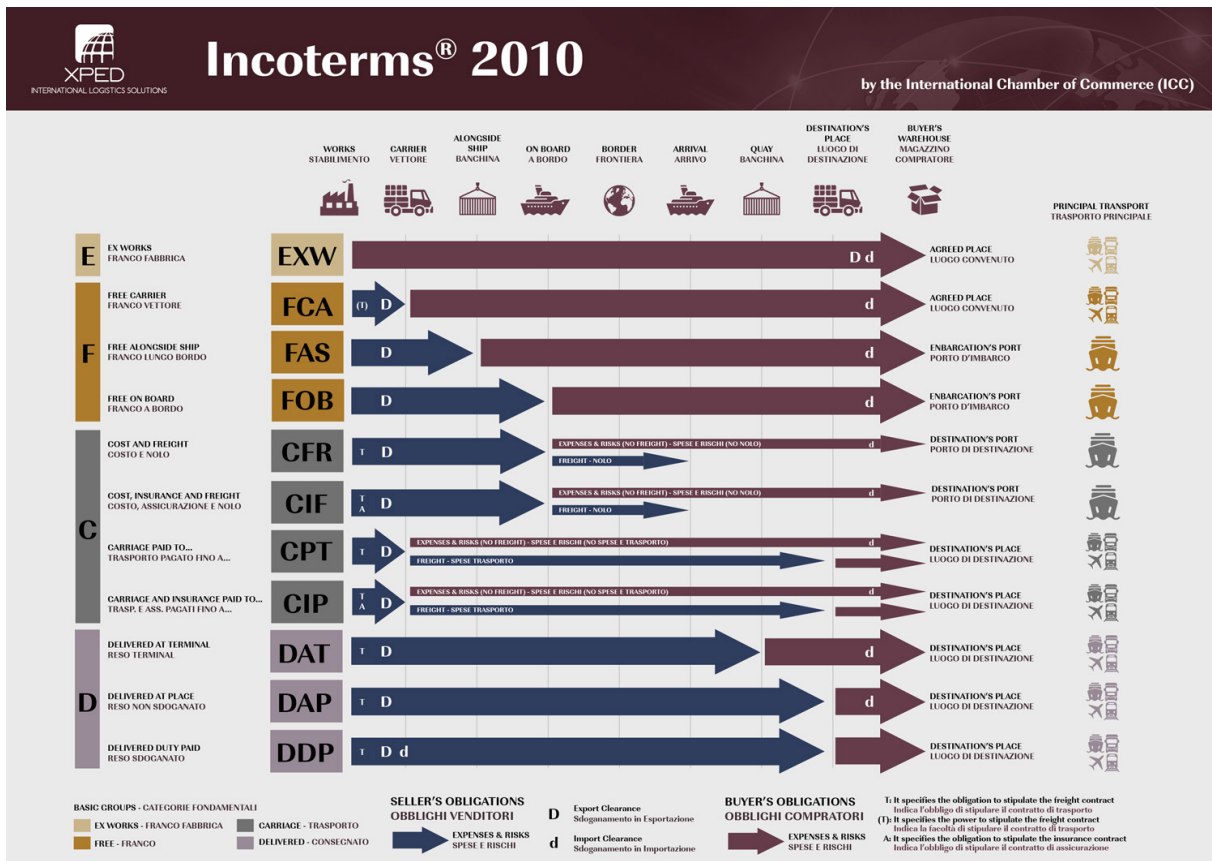


Figure 6 Incoterms 2010 (Xped International, 2018)

3.4 Site Management

Site Management consists of a few different stages of a project, stages such as installation and commissioning. (DepartmentofTrainingandWorkforceDevelopment, 2016)

Site Management also contributes to an overall better project control, this means that site personnel oversee the day-to-day operations on the site. Site Management is also responsible for ensuring safety on site, making sure that time schedule is fulfilled and that work related to site stays within budget. Finally, site management's role is to act as an initial contact between public and sub-contractor and lastly, to report progress to rest of project team. (CareerStructure, 2019)

3.5 Project cost estimation

Cost estimation for projects brings a lot of challenges since every project is unique and level of complexity is dependent on what type of project is being delivered. In this thesis the cost estimation for Power Plant Logistics and Site Management is the focus, both material costs and man-days costs will be considered.

3.7.1 Project cost estimation methods

Reaching a suitable balance between under estimation and over estimation of costs enables the company to manage the tension between the two elements of safety and risk. This means estimating costs that the customer can buy, and the seller can make profit from. According to Aston (2017) there are four stages which needs to be reviewed before creating a cost estimate;

- 1) *"Know the project"*. Before the cost estimation starts, the customer brief what are the goals they want to achieve with this project needs to be clarified.
- 2) *"Have a project budget"*. It is good to have some idea what the customer's budget is.
- 3) *"Have a plan for the project"*. Having some sort of a plan of the project is helpful when starting to estimate costs for the project. A project plan from an earlier executed project which is similar to the project that need cost estimation is also helpful to get a sense of what is needed to deliver a successful project.
- 4) *"Know why you're estimating"*. Cost estimation can be done for getting an accurate budget, estimating cost with the objective to hit a specific number or estimating cost for winning new businesses. When estimating costs for new businesses the project can be sold as a loss leader to ensure more projects down the line.

According to PMBOK (2013) the process of cost estimation is to develop an approximation of what is needed to complete project activities from a monetary resource perspective. PMBOK (2013) also emphasizes the importance of having a clear understanding of what the requirements are and what the deliverables are in order to be able to estimate cost accurately. Work Breakdown Structure or short WBS is the process where larger tasks are divided in to smaller tasks for which it is easier to estimate costs. (Lock, 2013)

3.5.2 Difficulties with estimating project costs

Although many companies have developed estimation tools to make the estimation process easier and more streamlined there are a lot of challenges with estimating costs. Challenges such as not getting accurate prices from suppliers, changing prices in transport and unexpected additional costs. Both under-estimating and over-estimating costs for a project can be hurtful since overestimating can lead to loss of sale of the project if a competitor can provide a better price. Underestimating costs for a project can lead to lower margin and in some cases even negative margin on the project which is bad for the company unless the objective of the project is to win a new market. According to Kerzner (2017) underestimating costs is often more devastating than overestimating costs for a project. The reason for this is that a low fixed price can contribute to winning the contract but in the long run loss of money for the contractor.

According to PMBOK (2013) cost estimation pitfalls consist of misinterpretation of the work, too optimistic schedule, improperly defined scope, inaccurate WBS, risk calculation failure and failure to understand inflation. Also, cost escalation and failure to calculate for overhead, general and administrative indirect costs are among the cost estimation pitfalls. According to Cobb (2015) there are two common problems when estimating costs for a project in planning stage, *Analysis paralysis* and *Cavalier approach*. The first one, *Analysis paralysis* refers to the process where contractor spends too much time and effort making detailed estimates with uncertain information or incomplete information. This problem often leads to commitment delays. The second problem, the *Cavalier approach* refers to the process where contractor neglects to manage risks and uncertainty and the project is started with minimal estimation or planning. The ideal situation for the contractor is somewhere in the middle of these two problems. Example from Lock (2013, s. 61), a cost estimation error of 7 percent can be considered as a quite small error by some, however, this 7 percent estimation error can actually contribute to a 40 percent lower gross profit than expected. The fact that profit is almost half of what was expected initially is the outcome which would be viewed by management and stakeholders.

3.5.3 Budgeting and following up costs in Wärtsilä Energy Business

Costs for projects are estimated when Gate 1 is passed, which is the start planning phase of the project. In this phase, preparing an offer is one of the main tasks. (Wärtsilä, 2017b)

The offer is prepared by sales organization with input from project organization. Sales organization calculates and reviews the contract on the amount of work, materials and time which is needed to execute the contract. When the offer is accepted by the customer, it is set to the contract and put into a *Cost Follow Up*. Costs are allocated to the correct activity in the *CFU*. The structure of the *CFU* is presented in Figure 7.

Project Structure	A Sales Budget (P1)	B Cost Budget (P2)	C Forecast (0)	D Actuals	E Ordered	C - D - E Estimate-to- complete	C - B Difference
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Figure 7 Structure of the Cost Follow up

The cost estimation is dependent on the project type and scope. Logistic costs are estimated and budgeted as Power Plant Logistics. Power Plant Logistics Work Breakdown Structure is split up in to activities as shown in Figure 8.

Materials for Logistics
Collection Transport - costs
Warehousing, Stevedoring & Custom
Main Shipment
Rest Deliveries Transport

Figure 8 Cost Follow Up activities Power Plant Logistic

Cost for logistic are estimated in CRM, which is a cost estimating software. However, CRM does not include all costs for logistics. Costs which are not included in CRM are estimated by offers, historical data and by road surveys.

Costs for the Site team are split in to various categories: Management costs, costs related to electrical management work, costs related to mechanical management work and costs related to civil management work.

Site Management costs are estimated by using cost estimation tool in CRM and by manually configuring how much Site Management is needed depending on what type of project needs cost estimation. Site Management cost include costs for Site Personnel such as administrative personnel, supervision and other relevant personnel. Site Management WBS and activities for a typical EPC project executed by Wärtsilä is presented in Figure 9. CRM calculates a price for Site Management man-days needed based of the total project time. (Wärtsilä, 2017b)

	Site Management
	Site Material
	Site management (salaries)
	Administration
	Travel/ accomm. & allowances
	Meetings & representation
	Service - Site tests
	Site Management - Electrical
Electrical	Subsupplier site work - Electrical
	Supervision & Commissioning -
Commissioning	Service Supervision &
	Site Management - Mechanical
Mechanical	Supervision & Commissioning -
	Service Supervision &
Commissioning	Site management - Civil
	Supervision - Civil

Figure 9 Cost Follow Up Activities Site Management

4 CONCLUSION

4.1 Was the purpose reached?

The purpose of this Thesis was to analyze cost estimation and check if there are improvements to be made to the estimating phase. If result shows that there are improvements to be made, what are then these improvements? This Thesis has indeed yielded some findings about things and processes that can be improved. These suggestions have come directly from people working with estimating costs. Since the improvement suggestions requires a significant amount of work in order for them to be implemented, a lot of discussion regarding how they should be implemented and by whom is needed and at the end of the day these improvement suggestions will cost money. Feasibility studies needs to be conducted if the improvement suggestions are possible. However, these suggestions will hopefully be a starting-point and attract for improvement to be made in the future.

In that sense this Thesis has served its purpose.

4.2 Challenges faced

A lot of challenges were faced during the analyzing process of this Thesis, since the WBS for both Power Plant Logistic and Site Management contains a lot of activities, there were a large number of ideas what the focus should be. Many ideas of what could be analyzed from interviews occurred.

Another challenge was to learn more about the actual cost estimating process within Wärtsilä Energy Business, since I had no earlier knowledge about how the cost estimating tool works or how costs are estimated in different areas this was something I had to learn more about. However, the most challenging part of this Thesis was the data collection and sorting. Since no costs for WBS were gathered from data extraction, I had to manually check the data. This was a blessing in disguise since it made me check the data quality at the same time, did the extracted data match with what I manually checked? Yes, it did, data quality of this thesis is in my opinion reliable.

4.3 Further research

As was mentioned earlier, a lot of ideas came up in interviews about what could be analyzed or further investigated. The one that I'm going to bring up here is the actual work of inserting historical data including dimensions and costs into a database which could be integrated with the sales tool to help in the cost estimating phase. Also the implementation of the improvements to the estimation tool would need to be figured out. Lastly, further research regarding the different activities and how each of them are estimated could be further investigated to check if current setup could be improved.

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