YRKESHÖGSKOLAN NOVIA

Product Configurator for a Wärtsilä 9L20 Containerized Power Plant

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EXAMENSARBETE

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Titel: Produktkonfigurator för ett Wärtsilä 9L20 kontainerkraftverk

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Abstrakt

Detta slutarbete presenterar skapandet av en produktkonfigurator för ett kraftverk byggt i kontainer. Kraftverket har en Wärtsilä 9L20 motor. Kraftverk har blivit byggda förut med denna motortyp men har då körts på tjockolja eller råolja. En ny design har undersökts samt fastställt för körandet på diesel. För att enkelt kunna skapa affärsförslag krävs att en produktkonfigurator skapas, som även sparar tid då användaren slipper att kolla upp priser på enskilda komponenter.

Syftet med detta slutarbete är att skapa en produktkonfigurator som möjliggör att användaren snabbt får ut ett affärsförslag på ett kontainerbyggt kraftverk bestående av en eller flera W9L20 motorer. Verktyget kommer att fungera som stöd i offereringsskedet av en potentiell affär och ger användaren ett bättre förstående över försäljningspriset samt minimerar mänskliga fel. Verktyget innehåller inte endast fysiska delar av kraftverket, även tjänster såsom projektledning och ingenjörskonst beaktas.

Resultatet är en produktkonfigurator, skapad i Excel, där användaren ges möjlighet att konfigurera ett kontainerbaserat W9L20 kraftverk. Verktyget kan snabbt skriva ut en leveransomfattning samt ger ett försäljningspris på lösningen i fråga. Syftet uppnåddes trots att konfiguratorn kan göras mer omfattande och inkludera fler variationer av det kontainerbyggda kraftverket.

Språk: Engelska Nyckelord: produktkonfigurator, affärsförslag, Excel

BACHELOR'S THESIS

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Abstract

This thesis presents the creation of a product configurator for a containerized power plant consisting of the Wärtsilä 9L20 engine. Containerized plants, built with W9L20 engines, have been done in the past but they have then been configured to operate with heavy fuel oil or crude oil. A new design has been investigated and determined for the operation with light fuel oil. In order to create quick proposals, a product configurator is required to get rid of time consuming price look-ups.

The purpose of this thesis is to build a product configurator tool for creating budgetary proposals for a power plant consisting of one or several Wärtsilä 9L20 engine(s). The tool will serve as a supportive one in the offering phase of a potential sale, and will give the user a better understanding of the final sales price of the complete solution in question. The tool does not only include physical items but services such as project management and engineering as well. Additional benefits with the tool is to minimize human mistakes and standardize the solution as much as possible.

The result of this thesis is a product configurator, made in Excel, where the user has the possibility to configure the W9L20 containerized power plant. The tool has the possibility to quickly create a scope of supply and a sales price of the solution. The goal was achieved, although the product configurator can be built bigger, including more variations of the containerized plant.

Language: English Key words: product configurator, business proposal, Excel

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1 Introduction

This chapter will present and overview the thesis, its background, purpose and problem area. After that the delimitations and confidentiality of the thesis is described and finally a disposition is presented which gives the reader a better understanding of the composition.

1.1 Background

The idea with this thesis came in connection with the change of ownership of the W9L20 engine, from Wärtsilä's Energy Solutions segment to Wärtsilä Services. Thus Wärtsilä Services are able to propose new built solutions with this engine type. At the same time customers have shown interest in a containerized power plant with medium speed engines, which the W9L20 engine is, which are operated with light fuel oil.

Containerized plants, built with W9L20 engines, have been done in the past but they have then been configured to operate with heavy fuel oil or crude oil. A new design has been investigated and determined for the operation with light fuel oil. In order to create quick proposals a product configurator is required to get rid of time consuming price look-ups.

1.2 Purpose

The purpose of this thesis is to build a product configurator tool for creating budgetary proposals for a power plant consisting of one or several Wärtsilä 9L20 engine(s). The tool will serve as a supportive one in the offering phase of a potential sale, and will give the user a better understanding of the final sales price of the complete solution in question. It will not only include costing of physical items such as an engine and auxiliary equipment but also services such as project management, engineering, installation, commissioning and site management.

The tool will be built in such a way that the user has the possibility to make certain choices on the start page, or configuration page. Based on the configurations made in the start page items and services will be included on a separate page which shows a summary of everything that is included, and not included, in the project. A sales price will be shown, with the possibility to change margins, at the end of the summary page.

One of the biggest choices that ought to be available in the tool is if the engines in question are to be run on light fuel oil (LFO) or heavy fuel oil (HFO). The start page of the tool, the page where the user gets to configure the solution, will have several available choices for the user to choose between. These will affect the project cost and ultimately the final sales price. The available choices, which affect the sales price the most, will be:

- Choice of area: Americas, Middle East and Asia, South Europe and Africa and North Europe. The choice of area will then determine the countries located in that area. In the end this will affect the cost of transportation.

- The choice of turbocharger.

- The choice of generator. This choice is dependant of the frequency used in the earlier chosen country (50Hz or 60Hz). The available generator voltages are also determined by the frequency in the chosen country.

- The choice of incoterm. The incoterms determine what portion of the whole transportation that is on Wärtsilä's and the customer's responsibility.

- The choice of fuel, heavy fuel oil or light fuel oil. This has the biggest effect on the sales price.

The tool will save time for Wärtsilä employees since time consuming manual price look-ups of certain critical equipment will not be needed. The long term aim is to get rid of excel-based tools and instead make budgetary proposals through Wärtsilä's CRM (customer relations management) system.

1.3 Problem Area

The W9L20 engine comes in several different design stages. In practice the different design stages mean minor modifications to the engine which result in different outputs. The problem is that the newest design stage (C6) of the W9L20 engine is designed for marine use. An engine which is meant to be run in a power plant on base load is not available as such at the moment.

Energy solutions, a branch of Wärtsilä, was responsible of the W9L20 engine, for power plant use, in the past but the responsibility and ownership of the product line has since moved to Wärtsilä Services. The product line is hence an outdated one, for power plant usage, and an investigation has to be made in order to verify the possibility to use an engine meant for marine use in a power plant, especially if the plant is to be fitted into a container.

Since the W9L20 engine is of such size that it fits within a high cube container, this kind of solution was offered from energy solutions in the past. Things to consider, if offering this kind of solution, is if a new CSC (Container Safety Convention) certificate has to be made. A CSC certificate means that the container, where the engine and auxiliary equipment is installed, is tested and approved for shipping. Output of the old design stage versus the new one will be unchanged. It is, however, uncertain if physical connection points and the generating set itself will fit the generator and base frame without further modifications. This needed to be verified.

Another important thing that has to be investigated is the usage of different fuels, in particular LFO (light fuel oil). Some customers demand the plant to be run at LFO today. The containerized plant has not yet been built to run on this type of fuel. The solution is normally run on HFO (heavy fuel oil) and consists then of two separate containers. One container where the generating set and surrounding equipment such as a container leak fuel unit, low voltage switchgear, two ventilation units, a container module, consisting mostly of piping, and a charge air filter is located. The second container, called the auxiliary container, consists of necessary auxiliary equipment such as cooling radiators, a ventilation unit but most notably the power skid.

The power skid is a module which consists of:

- A control panel
- Heat exchangers
- A fuel filter
- A fuel booster pump
- A mixing and de-aeration tank
- A fuel feeder pump
- Separators
- An engine pre-heater
- Air bottles

The above mentioned equipment is used when the engine is run on HFO. The Power skid is designed to fit within the auxiliary container. However if the engine is to be run on LFO, some equipment, such as separators, are not necessary anymore. This means that the design of the power skid used in a solution run on LFO needs to be determined. The goal, if the solution is run on LFO, is to get rid of the auxiliary container. Instead the LFO power skid would be fitted in the generating set container. A radiator field would be installed outside of the container, on a separate concrete slab.

At the moment, when offering a solution consisting of a W9L20 engine, the cost of the engine itself and auxiliary equipment has had to be looked up manually. This is not only time consuming but aspects mentioned above are not either clear. Neither is it clear if sub suppliers, who have provided necessary equipment for a functional power plant for this kind of purpose and of this kind, are able to manufacture needed equipment any longer.

1.4 Delimitation

Wärtsilä Project Sales ordered this thesis to get an understanding of necessary modifications to be done on the existing W20 engine in order to get it working in a power plant of containerized type. The necessary design modifications to the solution, when run on light fuel oil also needs to be investigated. An offering tool is also to be made in order to better understand costing of all things that are to be taken into consideration in the sales phase of a new power plant of this type.

This paper will only investigate the W9L20 engine, even though there are other engines in the W20 line.

1.5 Confidentiality

This thesis handles sensitive information that are not allowed to be shared outside Wärtsilä. All data included in the official version of this thesis is made up of random numbers. All enclosures, if any, will be classified and not included in the official version. The Excel based, budgetary proposal tool will only be shared within Wärtsilä.

1.6 Disposition

The first chapter introduced the reader to the background, purpose and problem area of the thesis. Delimitations and confidentiality are also discussed in brief.

The second chapter of the thesis will briefly present Wärtsilä, and also the organizational structure.

The third chapter will form a theoretical framework of this thesis. Basic information about business proposals and product configurators will be discussed

In the fourth chapter the reader will be introduced to the research approach and the methods used in creating the final result.

In the fifth chapter presents the result. Part of the product configurator is shown and discussed.

The sixth chapter discusses problems occurred on the way of doing this thesis. It also proposes further work to be done to the product configurator.

2 Wärtsilä in Brief

The Finnish corporation Wärtsilä was established 1834 in Tohmajärvi, Finland. In the early days Wärtsilä was a small milling company but has changed markets several times since. Today Wärtsilä is a global leader in advanced technologies and complete lifecycle solutions for both the marine and energy markets. Due to the company's integrated offering of both services and products it is well positioned on the global market. The company's main objective is: to achieve growth by offering their customers new and innovative solutions.

Wärtsilä's net sales totalled 4.8 billion euro in 2016 with approximately 18 000 employees. Wärtsilä has operations in more than 200 locations in over 70 countries all around the world. Wärtsilä is listed on Nasdaq Helsinki. (Wärtsilä, 2018a) (Wärtsilä, 2018b)

2.1 Company Segments

Wärtislä is divided into three main segments. These are: Energy solutions, Marine solutions and Services. The Energy solutions segment offer internal combustion engine based power plants, solar power plants as well as LNG terminals and distribution systems. Marine solutions offer manouvering systems for vessels which include multiple fuel engines, propellers and thrusters but also maintenance agreements and complete ship designs. Services focus lays on supporting Wärtsilä's customers throughout the whole lifecylce of their installations. The Service segment provide the most comprehensive portfolio of services and broadest service network in the industry, for both energy and marine markets. Services portion of the total net sales is almost 46% (2016). Looking at net sales by market area, Asia stands for the biggest portion with 37% of the business. (Wärtsilä, 2018c)

Figure 1: Net sales by market area.

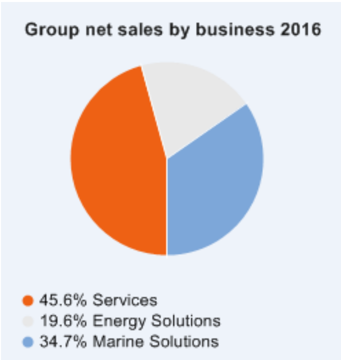

Figure 2: Net sales by business.

2.2 Wärtsilä Project Sales

Wärtsilä Project Sales consists of a team which is responsible for proposal management in project sales of a multi-portfolio nature, for both marine and power plant projects. Project Sales belongs to the Services segment.

When explaining what is meant by multi-portfolio projects one must first know the different solutions Wärtsilä has to offer. There are, for example, engines, propulsion systems, electrical & automation systens and ship design. When a project contains two or more of wärtsiläs solutions one can speak of a multi-portfolio project. With other words a multi-portfolio project is a more complex package than, for example, the delivering of an engine. (Wärtsilä, 2018d)

Examples of multi-portfolio projects:

- Fuel conversions
- Extension projects
- Re-location projects
- Vessel and plant efficiency projects
- Re-engineering projects

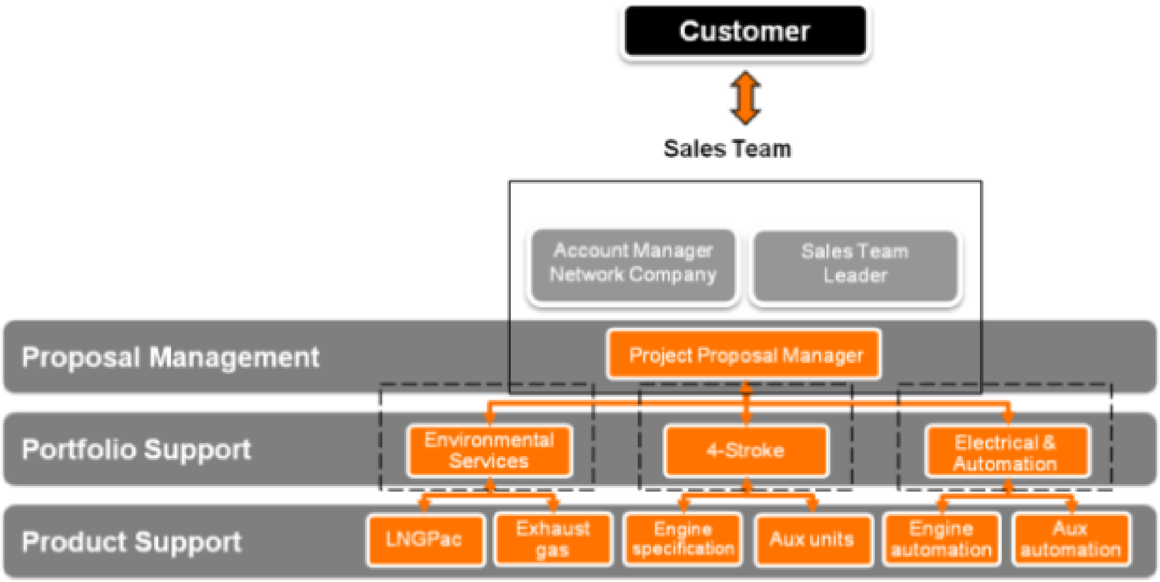

Figure 3: Organization of Project Sales.

3 Theory

This chapter will consist of a theoretical framework which will work as a foundation of this thesis. Theories about product configurators and basic information of business proposals will be presented.

3.1 Business proposals

In order for this thesis, and the excel tool which has been made to Wärtsilä, to be of any use at all the users of it needs to know how to create a good business proposal. It is not only the user that needs the knowledge, the person who is in direct contact with the end customer needs to know what the customer actually needs. This chapter will discuss what a business proposal is and some things to consider when writing one.

There are several and different definitions of what a business proposal is. It can be defined as a written offer from a sales person to a potential buyer. They are often one of the most important steps in a complex sales process (Newman, 2006). One good thing, and advantage, with proposals is that they put the potential buyer's requirements in a position that favours the sales person's products and services. A proposal educates the potential buyer of the sales person's competence to fulfil the needs of the buyer. (Ricci, 2014)

3.1.1 Different types of business proposals

Business proposals can be categorised into:

- Formally solicited proposals
- Informally solicited proposals
- Unsolicited proposals

The formally solicited proposals are written responses to publicly announced requirements. The requirements are included in a *request for proposal, request for quotation*, *invitation for bid* or *request for information*.

Request for proposals give detailed information and specifications of what the customer is in need of. These can include directions of how the seller is to prepare the proposal and how the customer will evaluate the proposal. Requests for proposals are often issued when the customer can't find a directly available product or solution which meet their requirements.

The customer sends out these requests to companies they see as fit to provide a solution to their problem.

Request for quotation letters are issued to potential companies when the customer wants to purchase large amounts of goods and the price of the goods is not the only issue. For example the customer might see availability or delivery time as factors that are as important, or more important, than the price itself.

Invitation for bid letters are issued by potential customers when they are in the market for some kind of service, such as maintenance work to an engine. In these cases price is the most important thing in the choosing of a supplying company for the customer.

Request for information letters are sometimes issued before the potential customer issues a request for proposal, request for quotation or request for bid. The purpose with this letter is for the potential customer to gain knowledge about what products, services and vendors that are available at the moment. (Newman, 2006)

The informally solicited proposals are often results of conversations between a sales person and potential customer. The potential customer is interested enough, of the product or service in question, to ask for a proposal from the sales person. In these kinds of cases the potential customer does not usually ask for proposals from other companies that are in the same market as the company providing the proposal. If that is the case this kind of proposal is called a *sole source proposal.*

The unsolicited proposals are marketing brochures and they are generic. This means that they have no connection with the needs of a specific customer. Companies use these brochures as introductions of products or services to a potential customer. These are often handed out at first meetings with new potential customers. (Khalsa, 2008)

3.1.2 Proposal build-up

Proposal writing can be made easier by using pre-made templates which contain necessary standard information that is used in most porposals. By doing this the people finalizing proposals only need to gather relevant information related to a specific case. Things that stay the same in the template could be the name of the company and qualifications. The person making a proposal of a specific product or service to a specific end buyer with certain needs could then only fill in the missing, relevant information. (Baugh, 2010)

Proposals should be based on done research in order to meet the potential customer’s needs. It is thus important that the person making a proposal has knowledge about the customer that is to recieve the proposal. Research of things, such as, general information of company should be done in advance. This increases the chance of creating a good proposal and will give the reciever of the proposal a good general idea of the outcome of the research earlier done. A typical format of a proposal has a title, abstract, a statement of the problem and a description of how to solve the problem, a price and biographical information.

It is especially important to focus on the main idea of what is being proposed. The writer of the proposal should point out what the idea is and try to make it stand out from others. Thereafter what can be done, and should be done, with the idea should be explained. Important is also that the proposal proves that the creator of it has the necessary competence and knowledge to write it. Everyone that has, in some way, provided something for the final proposal should be mentioned. What specific persons have contributed with should also be included. (Porte, 1967)

3.2 Product configurators and configurable solutions

When speaking of product configurators one could define it as an information system that manages products and their variants. This for doing adaptions of the product that are customer- specific. If a configurator is to be of any help in the sales-delivery process, the final product must be relatively easy to configure. The term sales-delivery process describes all phases required to propose, sell, order, manufacture and deliver a product to a customer. In other words: a configurable product aims at combining benefits of mass produced and unique products, while keeping the adaption as easy as possible to full-fill. (Juha Tiihonen, 2018)

The term *solution* is here used to mean a specification or design of an entity that a company sells. The term *component* is used to mean a specific physical item which is part of the solution. Several components may be integrated into a whole, this is called a *module.* The W9L20 containerized poweplant is partly built by different modules.

For a solution to be configurable it ought to have the following basic characteristics:

- The delivered solution is tailored to the needs of a specific customer.
- The component/module is pre-designed in order to meet a given variation of customer requirements.
- Each solution is specified as a combination of components, or modules, which means that there is no requirement to design new components as a part of the sales-delivery process.
- The component's structure or architecture has been pre-designed.

The first mentioned property in the list differentiates configurable solutions from mass produced products. The second property in the list reveals that there is a limited range of different customers that the solution is aimed at. This in turn means that the company's goal is not to satisfy all customers with the solution. (Juha Tiihonen, 2018) This is also the case when talking about a containerised power plant consisting of W9L20 engines.

3.3 Mass customization versus full customization

In this day customers demand products for many diverse needs. The term *mass customization* (MC) has been proposed as a more cost efficient method to the before mentioned problem than *full customization* (FC). Full customization means a solution that is made as a one-of-a-kind solution to a specific customer, depending on their specific needs. MC means the ability to provide products that are customized to specific customer needs on a large scale, close to mass production efficiency. One way of implementing MC is by the use of configurable products. A configurable product's design specifies a bunch of pre-designed elements and rules which determine how they can be combined into valid, functioning product individuals. (Mikko Heiskala, 2018) Since the light fuel oil concept of the containerized power plant has not yet been made, these are things that ought to be considered in the design stage of the solution.

A common challenge with MC is that it increases the need of managing information. An MC supplier takes the customer requirements (information) and translates them to a manufactured product. This information about the specific requirements flows through the supplier organization and crosses different organizational boundaries such as sales, manufacturing and distribution until it finally is delivered to the customer. The process increases the amount of information transferred in the supplier organization but MC also increases the need for product data and handling of different variations regarding the product. (Mikko Heiskala, 2018)

The manufacturing of customer specific products require flexibility from both the manufacturing department but also the logistics department. This can be difficult to achieve.

Since the final product is configured, different suppliers of components might be used in different cases depending on the customer’s needs. This might cause difficulties in achieving consistent quality. Further, the supplier has to manage variable costs instead of fixed costs, since few products are the same. An MC supplier needs to produce, sort, ship and deliver small amounts of differentiated products. This increases the complexity of production planning but also quality control. MC might require hiring and/or training highly skilled staff. (Mikko Heiskala, 2018)

The supplier will also face challenges related to the specification process. The most common cited challenge with MC is the difficulty to understand the customer’s needs and thus creating a valid sales specification. As customization increases so does both the complexity as well as the amount of required information. Sales might have incomplete or/and no longer valid configuration knowledge. This is one contributing factor to the specification errors.

Some specification errors that have been identified are:

- The specified product cannot be produced or would not work properly.
- The specified product might not meet the customer needs as good as it could.
- Pricing errors. The effective cost of producing the specified product might be higher than the sales price.
- An incorrect delivery time could be specified. (Mikko Heiskala, 2018)

In order to avoid these challenges sales and manufacturing need to exchange information between one another. Exchange of information is also needed between sales and other experts. Information exchange between my department and other experts at Wärtsilä is a common occurrence when figuring out if specific solutions can be done, and thus offered to different customers depending on their specific needs.

3.4 Recommendation technologies and features for configurable products

A user that uses a configurator application often needs advice in order to be able to answer questions such as which features are to be specified next, and which features that are applicable depending on the earlier choice. Another problem, for unexperienced users, might be what values the user could adapt in situations where no solution can be found. The next section will show the reader how recommendation technologies can be used in order to give an answer to the before mentioned problems.

Recommendation technologies can reduce over-heads that are related to the feature selection in different ways, such as:

- Features can be explicitly excluded if they are not needed in a certain context.
- Features can be ranked in such a way that the most relevant ones are easily accessed. (Falkner, 2018)

An example, in a car configurator, could be if the user wants to include a ski bag when the user earlier has chosen the car type to be a combi model. The option ski bag should then not be accessible since it is automatically included in a combi model.

An exclusion from a dialogue of features which are not relevant can, for example, be implemented by using process flows that define in which order certain questions or choices are presented to the user. (A. Felfering, 2008) This selection system of relevant questions can be explained as a simple type of knowledge-based recommendation where restrictions represent the conditions that must be fulfilled before other things can be done, for selecting questions. This method can be seen as inflexible since it is not able to focus on questions that are relevant to a specific user but it triggers additional knowledge engineering efforts. (Falkner, 2018)

Besides including or excluding features they can also be ranked according to their importance for the user or solution itself. It is important that state-of-the-art systems are flexible and active in a way that they support users in specifying their needs and selecting relevant features. (Pearl Pu, 2008) Features can be ranked by popularity, entropy and utility. (Falkner, 2018)

However ranking of features in the product configurator that I have made should only be done on basis of what is and what is not applicable based on previous feature choices. For example, the user has chosen that the final product is to be delivered to a country with a 50Hz frequency. The next available feature, which is the choice of generator, should be ranked according to which generator type is the preferred one and has been used in previous cases.

Often users specify requirements that require that two or more features, that are not applicable together, would be needed for the final product. In other words, features that are inconsistent with the product knowledge. A possibility to avoid this kind of situations is by only allowing the user to enter one requirement at a time and to prevent selectable features that constrain each other. This approach is however limited and does not allow the user to learn about the underlying product variety and the existing trade-offs between properties of the products. (Pearl Pu, 2008)

Instead of doing this one could use *minimal explanations* (Reiter, 1987) or *maximal relaxations* (Barr O'Sullivan, 2007). Minimal explanations means the minimal set of requirements that has to be adjusted or deleted so that a possible solution can be identified. Maximal relaxation means the complement of a minimal explanation.

By using recommendation technologies the risks of configuring a product that is not doable are minimized. Recommendation technologies could save time for companies that use product configurators since time consuming lookups of which features are applicable with other features are not needed. By using a system that ranks available choices based on earlier made choices, the user, in this case a sales person or proposal engineer, gets the optimal feature without having to manually investigate, or guess, what it in fact is. But recommendation technologies are not perfect. Implementing too many rules and regulations in a product configurator might cause the user not to learn enough about the final, configured product.

4 Method

This chapter will tell the reader how I have reached my main target with this thesis. It tells the reader about my course of actions and collection of information. Processing and analysing of imformation is also described, briefly. The information for this thesis was gathered mostly from journals, the internet and Wärtsilä's own internal sources. Discussions regarding this thesis have taken place during working hours within Wärtsilä.

Chapter 4.1 describes different research methods; qualitative and quantitative methods. Chapter 4.2 compares different investigation methods, the purpose is to find a suitable method for the purpose of this theses. In chapter 4.3

4.1 Different research methods

When choosing a research method one should base the choice depending on the problem of the research. Naturally the choice will be a combination of different research approaches. By combining different approaches one gets the benefits from the selected methods, in this case qualitative and quantitative methods. By combining different research methods the validity of the information is enhanced, this if both methods give the same result.

In the following two chapters quantitative and qualitative methods are presented to the reader.

4.1.1 Quantitative method

Quantitative research is based on earlier done research. This means that the information is readily available from the past and thus also available for the theory and problem formulation phase. The method has proven to be a valid one as long as the researcher is critical to both the information and the tools used in the research.

A problem with this method is that people tend to find information expressed in numbers as trustworthy. The information is thus easy to misuse and/or misinterpret. (Holme, 1997)

4.1.2 Qualitative method

The qualitative method is based on interviews. Thus the researcher will have a better relation to the information source than in the quantitative method. In the qualitative method, the focus on validating the gained information is not as important as it is in the quantitative method.

This due to that the purpose of the research is mainly to obtain a better understanding of certain factors, therefore the method will not have the statistical representativeness in focus. In other words the aim of the method is to obtain an aspect of a certain thing from someone that is involved in what the researcher is investigating. An example might be: a person that investigates daily routines of retired people. The investigator then wants to hear a group of retired people in different situations in order to get inputs from a variety of people.

A problem with this research method is that the questions for interviews or formulas can be steered to give a desired outcome, thus showing an untrue picture of the reality. Close relations between the researcher and the investigated group, or individual, might also cause problems. This because the investigated group, or individual, might then try to give such answers as the researcher strives the result of the investigation to be. (Holme, 1997)

4.2 The choice of method for this thesis

Personally I have chosen to use both the qualitative and quantitative method for my thesis. I see both methods as suitable. This because pricing on certain equipment needed to be updated to get a true sales price on the configured product but also because the product in question has been delivered before and thus information from the past is available.

For the empirical part I see the quantitative method as the suitable one, since product configurators have been done in the past and proven theories are available.

The inputs of pricing, regarding physical equipment, to the product configurator itself are collected from sub-suppliers but also from within Wärtsilä. Since containerized plants have been done in the past reference cases are available but in the end no case is alike.

4.3 Solution Approach

This section presents all methods used to come up with the final result. Values in presented figures are modified to X's if they consist of confidential data.

4.3.1 Platform selection

Before I began doing this thesis myself and my supervisor at Wärtsilä discussed if I would do the product configurator in Excel or in Wärtsilä's browser based configurator called APEX. Since APEX requires advanced programming skills Excel was the most natural choice.

Wärtsilä uses Office365 which contains different office tools, including Excel. Since Excel is a widely used spreadsheet program, most people are familiar with using it. By creating the tool in Excel no additional software is needed for those who are to use the final tool, also no education is needed for the users.

4.3.2 Physical items; prices

Since the latest W9L20 containerized power plant was sold in 2013 an update of prices had to be done. Quotations where asked by sub-suppliers but also gathered from earlier done cases. Requesting quotations of every single item, from different sub-suppliers, used in the final product would have been too time consuming.

Cost follow-ups were gathered from Wärtsilä's ERP-system, SAP. These also give information such as from which sub-supplier the item in question has been purchased from, order date, delivery date, incoterm and most importantly the price of the item. A cost follow up typically consist of several hundred rows. Small items with a low price compared to the total price of the complete solution where used from such cost follow-ups. These prices where then slightly marked up. I did not use a fixed mark-up factor, instead I marked up the prices with the help of my experienced colleagues.

Item description	Order date	Confirmed Delivery date	Required Quantity
W9L20 P/12030.M1PP1 Genser Power 3xW	05.06.2012		1
W9L20 P/12030.M1PP2 Genser Power 3xW	05.06.2012		1
W9L20 P/12030.M1PP3 Genser Power 3xW	05.06.2012		1
Generator	14.06.2012	05.10.2012	3
Roxtec system frames & packbits	14.06.2012	05.10.2012	3
Coupling Centamax CM 8000-SDE-70-21-320	21.06.2012	14.09.2012	3
Documentation in English	21.06.2012	14.09.2012	1
Fuel Oil Separator SAF927 Double Unit	21.06.2012	02.11.2012	1
Tools for Fuel Separator SAF927	21.06.2012	02.11.2012	1
Documentation in English	21.06.2012	02.11.2012	1
Pump and Filter Units ("CRO"/LFO),	26.06.2012	02.11.2012	3
Combined Feeder Booster unit HFO ("CRO")	26.06.2012	02.11.2012	1
LFO Feeder Unit,	26.06.2012	02.11.2012	1
Documentation in English,	26.06.2012	02.11.2012	1
Radiators.	27.06.2012	28.09.2012	3
Documentation in English.	27.06.2012	28.09.2012	1
Starting air compressor type HLF2/77	02.07.2012	01.10.2012	3
Documentation in English	02.07.2012	01.10.2012	1
Steel Springs	04.07.2012	12.10.2012	12
Documentation in English	04.07.2012	12.10.2012	1
Packing	04.07.2012	12.10.2012	1
Starting air vessel 250 L	04.07.2012	01.10.2012	3
Documentation in English	04.07.2012	01.10.2012	1
Expansion Vessel 100 L	04.07.2012		3
Documentation in English	04.07.2012	05.10.2012	1
Exhaust Gas Hose DN400	05.07.2012	05.10.2012	3
Documentation in English	05.07.2012	05.10.2012	1
Air Intake Filter and Silencer Unit,	06.07.2012	26.10.2012	3
Exhaust Gas Silencer with Spark arrestor	06.07.2012	26.10.2012	3
Exhaust Gas Adapter,	06.07.2012	26.10.2012	3
Emission mesurement nozzles,	06.07.2012	26.10.2012	3
Stack pipe insulation materials.	06.07.2012	15.11.2012	1
Ventilation Air Outlet Unit,	06.07.2012	26.10.2012	4
Ventilation Unit,	06.07.2012	26.10.2012	4
Ventilation Unit Sets/Aux,	06.07.2012	26.10.2012	3
Mask(Louvre) to Aux/genset container,	06.07.2012	26.10.2012	8
Ventilation Unit for Fuel Container,	06.07.2012	26.10.2012	1
Documentation in English,	06.07.2012	26.10.2012	1
Container Set Manufacturing Part 1.	12.07.2012	14.09.2012	1
Container Set Manufacturing Part 2.	12.07.2012	14.09.2012	1
Container Set Manufacturing Part 3.	12.07.2012	14.09.2012	2
Additional Roof Material Fuel Container	12.07.2012	28.09.2012	1
Documentation in English.	12.07.2012	14.09.2012	1
Flexible Crude Oil Hoses 1V60B0138 750mm	16.07.2012	19.10.2012	6
Dummy Pipe 3V60F0417 for assembly	16.07.2012	19.10.2012	1
Documentation	16.07.2012	19.10.2012	1
seaworthy packing	16.07.2012	19.10.2012	1
Generator Bellow.	19.07.2012	05.10.2012	3
Documentation in English.	19.07.2012	05.10.2012	1

Figure 4: Part of cost follow-up when exported from SAP to Excel.

days	months	Vendor name	PO item price	Terms of delivery
	30			
		WFI-ED Vaasa	XXX	
		WFI-ED Vaasa	XXX	
		WFI-ED Vaasa	XXX	
113	3.77	Cummins Generator Technologies	XXX	FCA,Ingolstadt (GER)
113	3.77	Cummins Generator Technologies	XXX	FCA,Ingolstadt (GER)
85	2.83	Centa-Antriebe Kirschey GmbH	XXX	FCA,VENDOR
85	2.83	Centa-Antriebe Kirschey GmbH	XXX	FCA,VENDOR
134	4.47	Alfa Laval Nordic Oy	XXX	FCA,KYRÖ
134	4.47	Alfa Laval Nordic Oy	XXX	FCA,KYRÖ
134	4.47	Alfa Laval Nordic Oy	XXX	FCA,KYRÖ
129	4.30	Auramarine Oy Ltd	XXX	FCA,LITTOINEN
129	4.30	Auramarine Oy Ltd	XXX	FCA,LITTOINEN
129	4.30	Auramarine Oy Ltd	XXX	FCA,LITTOINEN
129	4.30	Auramarine Oy Ltd	XXX	FCA,LITTOINEN
93	3.10	Alfa Laval Vantaa Oy	XXX	FCA,VANTAA
93	3.10	Alfa Laval Vantaa Oy	XXX	FCA,VANTAA
91	3.03	Sperre Industri AS	XXX	FCA,ÅLESUND
91	3.03	Sperre Industri AS	XXX	FCA,ÅLESUND
100	3.33	Vibratec Akustikprodukter Ab	XXX	FCA,BLIDÖ incl.
100	3.33	Vibratec Akustikprodukter Ab	XXX	FCA,BLIDÖ incl.
100	3.33	Vibratec Akustikprodukter Ab	XXX	FCA,BLIDÖ incl.
89	2.97	Uwira Oy	XXX	FCA,VAASA
89	2.97	Uwira Oy	XXX	FCA,VAASA
		Onkilahden Metalli Oy	XXX	FCA,MUSTASAARI
93	3.10	Onkilahden Metalli Oy	XXX	FCA,MUSTASAARI
92	3.07	Masino Trading Oy Vantaa	XXX	FCA,VENDOR
92	3.07	Masino Trading Oy Vantaa	XXX	FCA,VENDOR
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
132	4.40	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
112	3.73	JTK Power Oy/ Metalli-Jokela	XXX	FCA,VÖYRI
64	2.13	Conlog Oy	XXX	FCA,YLIKIIMINKI
64	2.13	Conlog Oy	XXX	FCA,YLIKIIMINKI
64	2.13	Conlog Oy	XXX	FCA,YLIKIIMINKI
78	2.60	Conlog Oy	XXX	FCA,YLIKIIMINKI
64	2.13	Conlog Oy	XXX	FCA,YLIKIIMINKI
95	3.17	Olympia Konevuokra Oy Rav-Kis	XXX	FCA,VAASA
95	3.17	Olympia Konevuokra Oy Rav-Kis	XXX	FCA,VAASA
95	3.17	Olympia Konevuokra Oy Rav-Kis	XXX	FCA,VAASA
95	3.17	Olympia Konevuokra Oy Rav-Kis	XXX	FCA,VAASA
78	2.60	TEXpro Oy	XXX	FCA,RAUMA
78	2.60	TEXpro Oy	XXX	FCA,RAUMA

Figure 5: Other part of cost follow-up when exported from SAP to Excel, prices not shown.

More important items, and items with a higher price relative the total price of the solution where quoted by different vendors. Quotation requests were done by email. The most critical items which needed updated prices were:

- Power skid for both HFO- and LFO-solution.
    - Quotations were requested from several companies, both Finnish and foreign ones, in order to get the best price. Delivery terms and manufacturing times were also considered and compared.
- Control panel
    - In this case quotations where requested by two different companies.
- Container material
    - Since the containers are CSC certified they need to be manufactured from a different material than traditional containers. To avoid re-doing the CSC certification the containers have to be identical to earlier done containers. Quotations were requested from several places and compared with each other.
- Charge air system, exhaust system and ventilation units
    - I knew what company Wärtsilä uses as the sub-supplier of these items from the past. Naturally quotations were requested by this company which is based in Finland.
- Cooling radiators
    - Quotations were requested from a certain company. No comparisons of prices where done.
- Generator
    - Quotations were requested from a company. Since this company has provided generators to containerized plants in the past we decided to only investigate available generator types from this company. This way additional verification is avoided regarding the usability of generators from other companies.

Wärtsilä also has annual agreements with some companies. Some prices were gathered from these agreements as well. Since the agreements only consist of more common items, manual requests, by email, had to be done as well.

When necessary prices of physical items had been collected they were put into Excel. Two sheets were created for prices of physical items; one for items included in the generating set container and another for items included in the auxiliary container. Since the LFO solution only consists of one container, items from both the auxiliary and the generating set container are used for this solution. Since some of the equipment listed in the tool are not needed in the LFO solution I used IF statements in excel in order to get the correct inputs depending on the configured product.

4.3.3 Non-physical items; prices

Project Business's purpose with the containerized plants is not only to sell the necessary equipment. The purpose is often to sell a project, which means it includes services such as project management, engineering, commissioning and delivery of equipment. Thus price estimations on these services had to be found out.

A meeting was arranged with two people working in the Services Energy Projects department at Wärtsilä. The purpose was to get an estimation of the time duration of a project consisting of one and several containerized plants. The time estimation was then translated into a cost. Included in the project management costing is also travel to the final plant destination, daily allowance, accommodation, taxi and/or car rental and some administrative costs. Daily allowance to different countries was looked up from www.vero.fi. The cost of flights was estimated by looking up actual flights to different locations of the world. Destinations close to one another where given the same costs. For example: Indonesia and Philippines are located somewhat close to each other. The cost of flight is then looked up to either one of the countries but the same cost is used for both countries.

Commissioning of the plants was also discussed during this meeting and an estimation regarding the cost was made. Commissioning was determined in the same way as project management; depending on number of generating sets and commissioning time per generating set.

The cost of project management was put into a separate sheet in the excel tool. Prices vary depending on number of generating sets and destination of the project. Daily allowance is also affected by the destination. Same goes for the commissioning cost estimate.

Regarding the LFO solution, an existing design was not available. Engineering was ordered from Citec. Device lists and roughly made layouts were provided to design engineers at

Citec. Based on that we got an offer for the design works. Since the design does not change case by case, the cost for engineering in the excel tool had to be lower than the quoted price from Citec. A price was however estimated based on the quotation provided by Citec, this was also put into a separate sheet in the tool. Cost of engineering does, however, not change depending on number of generating sets but depending on number of different sites. For example: ten containerized plants are sold to one customer. The customer has the intention of installing the containers into four different sites. The cost of engineering is then multiplied by four.

All of these different costs were added to different sheets in the tool. Costs are gathered to the summary page in the tool. The summary page shows all the costs related to a W9L20 container project.

4.3.4 Transportation prices

At the first page of the tool, the user has the possibility to choose an incoterm. The different incoterms available in the tool are: FCA, CIP and DAP.

The incoterms are partly based on their true meaning but they are simplified to always mean a certain thing in the tool:

- FCA means that Wärtsilä provides transportation to a port in Finland. Customer takes care of loading, ocean transport, unloading and inland transportation.

- CIP means that Wärtsilä provides transportation to a port in Finland, loading and ocean transport to a port of customer’s choice. Customer takes care of unloading and inland transportation.

- DAP means that Wärtsilä provides transportation to the destination of the site where the containers are to be installed.

A cost estimation of the different phases of the transportation needed to be done. The collection transportation, meaning the cost of transporting loose equipment from different manufacturers to a specific place where the containers are assembled and furnished was the biggest question mark. In some quotations, from the physical items, transportation was provided as a separate line. Based on this cost an estimation was made for the collection transportation part. Factors that affect the collection transportation part are distance between supplier and place of destination and weight of equipment. Not all physical items are transported by land either but by sea, but this is only the case for the HFO power skid. Which is shipped from India.

I did an estimation on the biggest items that make the most impact regarding cost in the collection transport part.

Collection transport estimate	From	To
Container material (HFO)	Poland, Gdansk	Naarajärvi
Container material (LFO)	Poland, Gdansk	Naarajärvi
Genset	Vasa	Naarajärvi
Turbocharger	Germany	Finland, Naarajärvi
Generator	Romania	Finland, Naarajärvi
W20 Power Skid (HFO)	India	Finland
W20 Power Skid (LFO)		
Container leak fuel unit	Vasa	Naarajärvi
Starting air unit	Norway, Ellingsöy	Naarajärvi
Start air bottle	Vasa	Naarajärvi
Expansion vessel	Vasa	Naarajärvi
Filter, silencer, vent. Unit	Vörå	Naarajärvi
TC washing unit	Vasa	Naarajärvi
BJA - & LV-switch gear	Vasa	Naarajärvi
Ventilation unit	Vörå	Naarajärvi
Ventilation air outlet unit	Vörå	Naarajärvi
Generator vent air unit + frame	Vörå	Naarajärvi
Preheating unit	-	-
Noise insulation	Poland, Gdansk	Naarajärvi
Doors	Poland, Gdansk	Naarajärvi
Pipes in container	Vasa	Naarajärvi
Valves & other loose components	Vasa (?)	Naarajärvi
Cable ladders in container	Vasa (?)	Naarajärvi
Cables	Vasa (?)	Naarajärvi
Starting air compressor, frame	-	-
Preheating unit, frame	-	-
EL panels, frame	-	-
Engine platform	Vasa	Naarajärvi
Extra platform		
Frequency converter	Vasa	Naarajärvi
Charge Air duct	Vörå	Naarajärvi
Charge Air compensator	Vörå	Naarajärvi
Exhaust gas duct parts	Vörå	Naarajärvi
Bellows	Vörå	Naarajärvi
Lights	Vanda	Naarajärvi
Lifting bar	-	-
Locking sleeves	-	-
Other small components	Different places	Naarajärvi
SUM (LFO)		
SUM (HFO)		

Figure 6: Leftmost part of the collection transport estimate

Weight (kg)	Cost	Distance (km)
13400	XXXX	1500
6700	XXXX	1500
23000	XXXX	350
340	XXXX	2000
9200	XXXX	3000
1738	XXXX	
1800	XXXX	350
86	XXXX	350
750	XXXX	1400
227	XXXX	350
0	XXXX	350
1100	XXXX	320
20	XXXX	350
400	XXXX	350
375	XXXX	320
60	XXXX	320
97	XXXX	320
161	XXXX	
	XXXX	
200	XXXX	1500
1000	XXXX	1500
94	XXXX	350
100	XXXX	350
200	XXXX	350
500	XXXX	350
85	XXXX	
48	XXXX	
91	XXXX	
150	XXXX	350
131	XXXX	
35	XXXX	350
30	XXXX	320
20	XXXX	320
30	XXXX	320
100	XXXX	320
50	XXXX	300
23	XXXX	
52	XXXX	
200	XXXX	
	XXXX	
	XXXX	

Figure 6: Rightmost part of the collection transport estimate. Costs are replaced by X's.

Figure 5 and 6 show the most critical items when it comes to collection transportation. I partly estimated the weight of the items listed, but most were available from Wärtsilä's own drawings. Distance between supplier and end destination, Rauma, where the containers are to be furnished, I looked up with Google maps.

The next cost, which is included in all incoterm choices, is the transportation from the place where the containers are furnished to a port from where the containers are shipped. This cost was collected by a logistics expert at Wärtsilä. Transportation from place of furnishing to port of shipment changes depending on the choice of fuel, since the HFO solution consists of two containers instead of one as is the case in the LFO solution. Loading of containers to a shipping vessel was also estimated by the same person.

Next estimation that needed to be done regarding transportation was the ocean shipment part. This was done by asking quotations of a HFO and LFO solution to different parts of the world. I asked quotations to the following places:

- From Rauma to New York, United States
- From Rauma to Anchorage, Alaska
- From Rauma to Venezuela
- From Rauma to Buenos Aires, Argentina
- From Rauma to Turkey
- From Rauma to South Africa
- From Rauma to Shanghai, China
- From Rauma to Fiji

These final destinations were chosen because, in my opinion, they cover most of the world. The destinations cover all continents. Based on the quotations that I received, an estimation was done to other parts of the world. The cost is affected by distance and weight of the container. In the HFO solution case, the weight of the generating set container is heavier than the auxiliary container. In the LFO solution case, the container weighs more than the HFO generating set container. This is the reason why I asked separate quotations on both solutions.

The quoted costs of ocean transport and the calculated estimations where put into a separate sheet in the tool. The cost is collected to another sheet in the tool depending on what country is chosen in the start page of the tool. This was done with the excel function VLOOKUP.

		HFO		Total	LFO
Area	Destination	Gen-set cont. Cost	Aux cont. Cost		Cost
AMER	Anguilla	XXXX	XXXX	XXXX	XXXX
AMER	Antigua and Barbuda	XXXX	XXXX	XXXX	XXXX
AMER	Argentina	XXXX	XXXX	XXXX	XXXX
AMER	Aruba	XXXX	XXXX	XXXX	XXXX
AMER	Bahamas	XXXX	XXXX	XXXX	XXXX
AMER	Barbados	XXXX	XXXX	XXXX	XXXX
AMER	Belize	XXXX	XXXX	XXXX	XXXX
AMER	Bermuda	XXXX	XXXX	XXXX	XXXX
AMER	Bolivia	XXXX	XXXX	XXXX	XXXX
AMER	Bonaire	XXXX	XXXX	XXXX	XXXX
AMER	Brazil	XXXX	XXXX	XXXX	XXXX
AMER	Canada	XXXX	XXXX	XXXX	XXXX
AMER	Cayman Islands	XXXX	XXXX	XXXX	XXXX
AMER	Chile	XXXX	XXXX	XXXX	XXXX
AMER	Colombia	XXXX	XXXX	XXXX	XXXX
AMER	Costa Rica	XXXX	XXXX	XXXX	XXXX
AMER	Cuba	XXXX	XXXX	XXXX	XXXX
AMER	Curacao	XXXX	XXXX	XXXX	XXXX
AMER	Dominica	XXXX	XXXX	XXXX	XXXX
AMER	Dominican Republic	XXXX	XXXX	XXXX	XXXX
AMER	Ecuador	XXXX	XXXX	XXXX	XXXX
AMER	El Salvador	XXXX	XXXX	XXXX	XXXX
AMER	Falkland Islands	XXXX	XXXX	XXXX	XXXX
AMER	French Guiana	XXXX	XXXX	XXXX	XXXX
AMER	Grenada	XXXX	XXXX	XXXX	XXXX
AMER	Guatemala	XXXX	XXXX	XXXX	XXXX
AMER	Guyana	XXXX	XXXX	XXXX	XXXX
AMER	Haiti	XXXX	XXXX	XXXX	XXXX
AMER	Honduras	XXXX	XXXX	XXXX	XXXX
AMER	Jamaica	XXXX	XXXX	XXXX	XXXX
AMER	Mexico	XXXX	XXXX	XXXX	XXXX
AMER	Montserrat	XXXX	XXXX	XXXX	XXXX
AMER	Nicaragua	XXXX	XXXX	XXXX	XXXX
AMER	Panama	XXXX	XXXX	XXXX	XXXX
AMER	Paraguay	XXXX	XXXX	XXXX	XXXX
AMER	Peru	XXXX	XXXX	XXXX	XXXX
AMER	Puerto Rico	XXXX	XXXX	XXXX	XXXX
AMER	Saint Kitts And Nevis	XXXX	XXXX	XXXX	XXXX
AMER	Saint Lucia	XXXX	XXXX	XXXX	XXXX
AMER	Saint Vincent And The Grenadines	XXXX	XXXX	XXXX	XXXX
AMER	Suriname	XXXX	XXXX	XXXX	XXXX
AMER	Trinidad And Tobago	XXXX	XXXX	XXXX	XXXX
AMER	Turks And Caicos Islands	XXXX	XXXX	XXXX	XXXX
AMER	United States	XXXX	XXXX	XXXX	XXXX
AMER	Uruguay	XXXX	XXXX	XXXX	XXXX
AMER	Venezuela	XXXX	XXXX	XXXX	XXXX
AMER	Virgin Islands, British	XXXX	XXXX	XXXX	XXXX
AMER	Virgin Islands (US)	XXXX	XXXX	XXXX	XXXX

Figure 7: Sea freight cost of countries located in the Americas area. Actual costs are replaced by X's.

MEA	Afghanistan	XXXX	XXXX	XXXX	XXXX
MEA	American Samoa	XXXX	XXXX	XXXX	XXXX
MEA	Australia	XXXX	XXXX	XXXX	XXXX
MEA	Bahrain	XXXX	XXXX	XXXX	XXXX
MEA	Bangladesh	XXXX	XXXX	XXXX	XXXX
MEA	Bhutan	XXXX	XXXX	XXXX	XXXX
MEA	Brunei	XXXX	XXXX	XXXX	XXXX
MEA	Cambodia	XXXX	XXXX	XXXX	XXXX
MEA	China	XXXX	XXXX	XXXX	XXXX
MEA	Christmas Island	XXXX	XXXX	XXXX	XXXX
MEA	Cocos (Keeling) Islands	XXXX	XXXX	XXXX	XXXX
MEA	Cook Islands	XXXX	XXXX	XXXX	XXXX
MEA	Fiji	XXXX	XXXX	XXXX	XXXX
MEA	Guam	XXXX	XXXX	XXXX	XXXX
MEA	Hong Kong	XXXX	XXXX	XXXX	XXXX
MEA	India	XXXX	XXXX	XXXX	XXXX
MEA	Indonesia	XXXX	XXXX	XXXX	XXXX
MEA	Iran	XXXX	XXXX	XXXX	XXXX
MEA	Iraq	XXXX	XXXX	XXXX	XXXX
MEA	Japan	XXXX	XXXX	XXXX	XXXX
MEA	Jordan	XXXX	XXXX	XXXX	XXXX
MEA	Kiribati	XXXX	XXXX	XXXX	XXXX
MEA	Korea, North	XXXX	XXXX	XXXX	XXXX
MEA	Korea, South	XXXX	XXXX	XXXX	XXXX
MEA	Kuwait	XXXX	XXXX	XXXX	XXXX
MEA	Laos	XXXX	XXXX	XXXX	XXXX
MEA	Lebanon	XXXX	XXXX	XXXX	XXXX
MEA	Macao	XXXX	XXXX	XXXX	XXXX
MEA	Malaysia	XXXX	XXXX	XXXX	XXXX
MEA	Maldives	XXXX	XXXX	XXXX	XXXX
MEA	Micronesia	XXXX	XXXX	XXXX	XXXX
MEA	Mongolia	XXXX	XXXX	XXXX	XXXX
MEA	Myanmar	XXXX	XXXX	XXXX	XXXX
MEA	Nauru	XXXX	XXXX	XXXX	XXXX
MEA	Nepal	XXXX	XXXX	XXXX	XXXX
MEA	New Zealand	XXXX	XXXX	XXXX	XXXX
MEA	Oman	XXXX	XXXX	XXXX	XXXX
MEA	Pakistan	XXXX	XXXX	XXXX	XXXX
MEA	Palau	XXXX	XXXX	XXXX	XXXX
MEA	Papua New Guinea	XXXX	XXXX	XXXX	XXXX
MEA	Philippines	XXXX	XXXX	XXXX	XXXX
MEA	Pitcairn	XXXX	XXXX	XXXX	XXXX
MEA	Qatar	XXXX	XXXX	XXXX	XXXX
MEA	Samoa	XXXX	XXXX	XXXX	XXXX
MEA	Saudi Arabia	XXXX	XXXX	XXXX	XXXX
MEA	Singapore	XXXX	XXXX	XXXX	XXXX
MEA	Solomon Islands	XXXX	XXXX	XXXX	XXXX
MEA	Sri Lanka	XXXX	XXXX	XXXX	XXXX
MEA	Syria	XXXX	XXXX	XXXX	XXXX
MEA	Taiwan	XXXX	XXXX	XXXX	XXXX
MEA	Thailand	XXXX	XXXX	XXXX	XXXX
MEA	Timor-Leste	XXXX	XXXX	XXXX	XXXX
MEA	Tonga	XXXX	XXXX	XXXX	XXXX
MEA	Tuvalu	XXXX	XXXX	XXXX	XXXX
MEA	United Arab Emirates	XXXX	XXXX	XXXX	XXXX
MEA	Vanuatu	XXXX	XXXX	XXXX	XXXX
MEA	Vietnam	XXXX	XXXX	XXXX	XXXX
MEA	Yemen	XXXX	XXXX	XXXX	XXXX

Figure 8: Sea freight costs to countries located in the Middle East and Asia area.

NE	Aland Islands	XXXX	XXXX	XXXX	XXXX
NE	Armenia	XXXX	XXXX	XXXX	XXXX
NE	Austria	XXXX	XXXX	XXXX	XXXX
NE	Belarus	XXXX	XXXX	XXXX	XXXX
NE	Belgium	XXXX	XXXX	XXXX	XXXX
NE	Bulgaria	XXXX	XXXX	XXXX	XXXX
NE	Czech Republic	XXXX	XXXX	XXXX	XXXX
NE	Denmark	XXXX	XXXX	XXXX	XXXX
NE	Estonia	XXXX	XXXX	XXXX	XXXX
NE	Faroe Islands	XXXX	XXXX	XXXX	XXXX
NE	Finland	XXXX	XXXX	XXXX	XXXX
NE	Germany	XXXX	XXXX	XXXX	XXXX
NE	Greenland	XXXX	XXXX	XXXX	XXXX
NE	Hungary	XXXX	XXXX	XXXX	XXXX
NE	Iceland	XXXX	XXXX	XXXX	XXXX
NE	Ireland	XXXX	XXXX	XXXX	XXXX
NE	Isle Of Man	XXXX	XXXX	XXXX	XXXX
NE	Latvia	XXXX	XXXX	XXXX	XXXX
NE	Liechtenstein	XXXX	XXXX	XXXX	XXXX
NE	Lithuania	XXXX	XXXX	XXXX	XXXX
NE	Luxembourg	XXXX	XXXX	XXXX	XXXX
NE	Moldova	XXXX	XXXX	XXXX	XXXX
NE	Netherlands	XXXX	XXXX	XXXX	XXXX
NE	Norway	XXXX	XXXX	XXXX	XXXX
NE	Poland	XXXX	XXXX	XXXX	XXXX
NE	Romania	XXXX	XXXX	XXXX	XXXX
NE	Russia	XXXX	XXXX	XXXX	XXXX
NE	Slovakia	XXXX	XXXX	XXXX	XXXX
NE	Sweden	XXXX	XXXX	XXXX	XXXX
NE	Switzerland	XXXX	XXXX	XXXX	XXXX
NE	Ukraine	XXXX	XXXX	XXXX	XXXX
NE	United Kingdom	XXXX	XXXX	XXXX	XXXX

Figure 9: Sea freight costs to countries located in the North Europe area.

SEAF	Albania	XXXX	XXXX	XXXX	XXXX
SEAF	Algeria	XXXX	XXXX	XXXX	XXXX
SEAF	Andorra	XXXX	XXXX	XXXX	XXXX
SEAF	Angola	XXXX	XXXX	XXXX	XXXX
SEAF	Azerbaijan	XXXX	XXXX	XXXX	XXXX
SEAF	Benin	XXXX	XXXX	XXXX	XXXX
SEAF	Bosnia And Herzegovina	XXXX	XXXX	XXXX	XXXX
SEAF	Botswana	XXXX	XXXX	XXXX	XXXX
SEAF	Burkina Faso	XXXX	XXXX	XXXX	XXXX
SEAF	Burundi	XXXX	XXXX	XXXX	XXXX
SEAF	Cameroon	XXXX	XXXX	XXXX	XXXX
SEAF	Cape Verde	XXXX	XXXX	XXXX	XXXX
SEAF	Central African Republic	XXXX	XXXX	XXXX	XXXX
SEAF	Chad	XXXX	XXXX	XXXX	XXXX
SEAF	Comoros	XXXX	XXXX	XXXX	XXXX
SEAF	Congo	XXXX	XXXX	XXXX	XXXX
SEAF	Congo, Democratic Republic Of	XXXX	XXXX	XXXX	XXXX
SEAF	Croatia	XXXX	XXXX	XXXX	XXXX
SEAF	Cyprus	XXXX	XXXX	XXXX	XXXX
SEAF	Djibouti	XXXX	XXXX	XXXX	XXXX
SEAF	Egypt	XXXX	XXXX	XXXX	XXXX
SEAF	Equatorial Guinea	XXXX	XXXX	XXXX	XXXX
SEAF	Eritrea	XXXX	XXXX	XXXX	XXXX
SEAF	Ethiopia	XXXX	XXXX	XXXX	XXXX
SEAF	France	XXXX	XXXX	XXXX	XXXX
SEAF	Gabon	XXXX	XXXX	XXXX	XXXX
SEAF	Gambia	XXXX	XXXX	XXXX	XXXX
SEAF	Georgia	XXXX	XXXX	XXXX	XXXX
SEAF	Ghana	XXXX	XXXX	XXXX	XXXX
SEAF	Gibraltar	XXXX	XXXX	XXXX	XXXX
SEAF	Greece	XXXX	XXXX	XXXX	XXXX
SEAF	Guinea	XXXX	XXXX	XXXX	XXXX
SEAF	Guinea-Bissau	XXXX	XXXX	XXXX	XXXX
SEAF	Israel	XXXX	XXXX	XXXX	XXXX
SEAF	Italy	XXXX	XXXX	XXXX	XXXX
SEAF	Ivory Coast (Cote D'Ivoire)	XXXX	XXXX	XXXX	XXXX
SEAF	Kazakhstan	XXXX	XXXX	XXXX	XXXX
SEAF	Kenya	XXXX	XXXX	XXXX	XXXX
SEAF	Kyrgyzstan	XXXX	XXXX	XXXX	XXXX

Figure 10: Part of sea freight costs to countries located in the South Europe and Africa area.

SEAF	Lesotho	XXXX	XXXX	XXXX	XXXX
SEAF	Liberia	XXXX	XXXX	XXXX	XXXX
SEAF	Libya	XXXX	XXXX	XXXX	XXXX
SEAF	Macedonia	XXXX	XXXX	XXXX	XXXX
SEAF	Madagascar	XXXX	XXXX	XXXX	XXXX
SEAF	Malawi	XXXX	XXXX	XXXX	XXXX
SEAF	Mali	XXXX	XXXX	XXXX	XXXX
SEAF	Malta	XXXX	XXXX	XXXX	XXXX
SEAF	Mauritania	XXXX	XXXX	XXXX	XXXX
SEAF	Mauritius	XXXX	XXXX	XXXX	XXXX
SEAF	Mayotte	XXXX	XXXX	XXXX	XXXX
SEAF	Monaco	XXXX	XXXX	XXXX	XXXX
SEAF	Montenegro	XXXX	XXXX	XXXX	XXXX
SEAF	Morocco	XXXX	XXXX	XXXX	XXXX
SEAF	Mozambique	XXXX	XXXX	XXXX	XXXX
SEAF	Namibia	XXXX	XXXX	XXXX	XXXX
SEAF	Niger	XXXX	XXXX	XXXX	XXXX
SEAF	Nigeria	XXXX	XXXX	XXXX	XXXX
SEAF	Portugal	XXXX	XXXX	XXXX	XXXX
SEAF	Réunion	XXXX	XXXX	XXXX	XXXX
SEAF	Rwanda	XXXX	XXXX	XXXX	XXXX
SEAF	San Marino	XXXX	XXXX	XXXX	XXXX
SEAF	Sao Tome And Principe	XXXX	XXXX	XXXX	XXXX
SEAF	Senegal	XXXX	XXXX	XXXX	XXXX
SEAF	Serbia	XXXX	XXXX	XXXX	XXXX
SEAF	Seychelles	XXXX	XXXX	XXXX	XXXX
SEAF	Sierra Leone	XXXX	XXXX	XXXX	XXXX
SEAF	Slovenia	XXXX	XXXX	XXXX	XXXX
SEAF	Somalia	XXXX	XXXX	XXXX	XXXX
SEAF	South Africa	XXXX	XXXX	XXXX	XXXX
SEAF	Spain	XXXX	XXXX	XXXX	XXXX
SEAF	Sudan	XXXX	XXXX	XXXX	XXXX
SEAF	Swaziland	XXXX	XXXX	XXXX	XXXX
SEAF	Tanzania	XXXX	XXXX	XXXX	XXXX
SEAF	Togo	XXXX	XXXX	XXXX	XXXX
SEAF	Tunisia	XXXX	XXXX	XXXX	XXXX
SEAF	Turkey	XXXX	XXXX	XXXX	XXXX
SEAF	Uganda	XXXX	XXXX	XXXX	XXXX
SEAF	Uzbekistan	XXXX	XXXX	XXXX	XXXX
SEAF	Zambia	XXXX	XXXX	XXXX	XXXX
SEAF	Zimbabwe	XXXX	XXXX	XXXX	XXXX

Figure 11: Other part of sea freight costs to countries located in the South Europe and Africa area.

Even though many of the countries shown in figures seven to eleven are not located by the sea these are included as a choice in the tool. Costs for such countries were left as the same as the nearest country located by the sea. For example: a country located in the middle of Africa does not have a port. The cost of transportation to the nearest country with a port is then instead used.

The unloading of the containers and inland transportation is only included if the user selects the DAP incoterm. These are a small portion of the total transportation cost and where thus estimated with the help of my colleagues at Wärtsilä. No further investigations were done to these phases of the transportation. Airfreight is also included in all available incoterms in the tool. This because, regarding to my colleagues, there is most often a need of a small number of airfreights during a project. This cost was also just an estimation, since this is also a small portion of the total transportation cost.

4.3.5 Price of furnishing containers

Another important part, regarding cost that affects the final sales price is the furnishing of the containers. Furnishing of the containers means that all necessary equipment is installed to a container that is manufactured by special walls, roof, floor and doors. We asked many different companies for quotations of this work. Another thing, associated to the containers that needed to be investigated was the container material. Since the containers are CSC certified from the past and the certification is only valid if the container is manufactured from the same material as before, we needed to find a company that could manufacture the container material according to our specifications. When having received several quotations a company was chosen to do the furnishing part. Suppliers of the container material was also chosen.

For the furnishing part quotations were asked separately to the HFO and the LFO solution. We asked quotations on one set of containers and nineteen sets. This to see if the price fluctuates depending on quantities of containers. When receiving the quotations we noticed that prices do actually change depending on the amount of containers. Based on the two quotations a price estimation was made depending on different amounts of containers. The estimation was made by creating a graph in excel. Different values were determined simply by looking at the graph. The cost estimates were put into a separate sheet in the tool. The cost is affected by how many engines the user chooses in the start page of the tool.

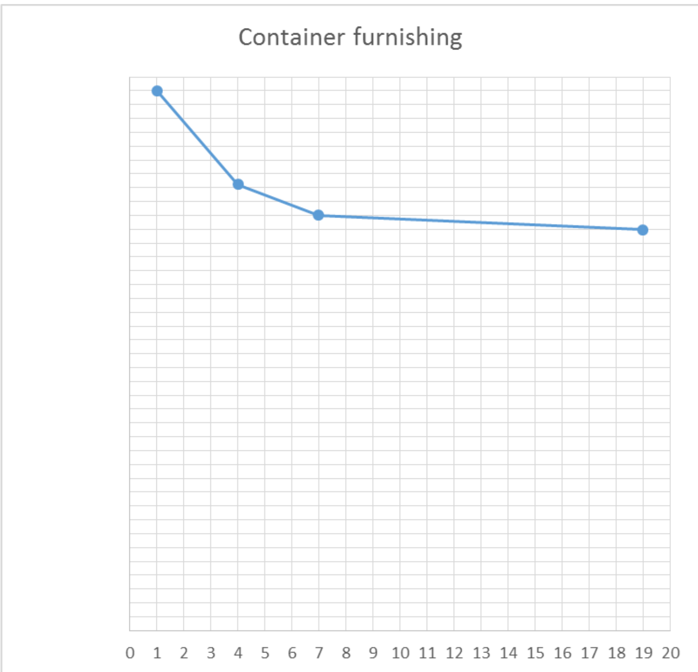

Figure 12: Graph of the cost estimation of container furnishing. Prices are removed from the y-axis. X-axis shows number of containers.

4.4 Critical view of method

Since costs of some physical items have been estimated based on earlier sold cases, the user of the configurator should be critical to these items, regarding cost. A mark-up has been done to these items by the help of experienced co-workers.

Since non-physical services such as project management have been estimated by two people alone one should also be critical to these costs. Since all projects are different so is also working hours spent on a project. The cost of engineering is often case specific, no site is the other alike. Thus the cost reserved for engineering could in some cases be more than enough and in others, perhaps too low.

Since there are lots of selectable countries in the tool it would have been too time consuming to ask quotations of transport to every single country. Since estimations have been made, based on the quotations received to a small number of locations, the user should also be critical to this part.

In the end the project configurator should be used for creating proposals in an early stage of a potential sales case. The sales price is only an estimation and should not be used as a firm sales price.

4.5 Implementation

This thesis was done by myself with the support of my supervisors from Wärtsilä and my supervisor from Novia. Since most of the required data for the tool was easier to access from Wärtsilä, and help is there nearby when needed, it has been done at Wärtsilä in Runsor. It has taken approximately five months to complete the product configurator, not including the writing of this thesis.

The planning of this work began in September 2017. I quickly formed a model of how the configurator might look in the end. When the planning of the tool, and data required to do it, was clear, me and my supervisors started collecting required data for it. It has taken a long time to collect required quotations on certain equipment and the design for the light fuel oil container. When awaiting quotations and things alike, I have simultaneously built the configurator in Excel. The hardest part with this work has been to keep track of different mail conversations and obtained quotations. My inbox is full of information regarding the W9L20 containers. At the beginning it was pretty hard to get an image of how the final product configurator will look, but the result is pleasing, atleast to me.

5 Results

This chapter will present the final result with this thesis. The product configurator tool, done in Excel, will be presented. The tool's features will also be presented.

5.1 Product configurator; start page

The start page is one of the most important pages in the tool for the user. It is here that the user gets to configure the W9L20 containerized solution. Figure 13 shows the different categories that have different choices. The green cells are fields that the user himself, or herself, can configure. The blue cells change automatically depending on earlier done choices. In this case the cells called "Frequency" and "Engine speed" change depending on what country is chosen earlier. The available countries to choose from are also affected by which area the user has chosen before. For example: the user chooses "AMER" in the area field. The tool then filters all countries located in this area so that only countries located there are visible, selectable choices. Let us say that the user chooses the country Cuba. The "Frequency" cell is then automatically populated with "60 Hz", since that is the frequency used in that country. The cell "Engine speed" is also populated automatically. In this case with "900 rpm".

Further on the choice of voltage, in this case the voltage of the generator, is dependent of the frequency. There are only a few different voltage choices at this moment in the tool. Let us say we still have the country "Cuba", as in the example before, and the frequency 60 Hz. The available voltage choices are then 4.16 kV and 6.6 kV.

The cell called "Transportation" has three options behind it. These are "FCA", "CIP" and "DAP", which are incoterms. The meaning of the incoterms in this tool are described in chapter 4.3.4. The cell called "Setup" refers to what type of project the user wishes to configure. The cell has two options; EPC and EEQ. EPC stands for "Engineering, procurement and construction" and refers to a power plant that is delivered to a customer ready for operation (Wärtsilä, 2018e). EEQ stands for "Engineering equipment delivery" and means that equipment, for a power plant, are engineered and delivered to a customer (Wärtsilä, 2018f).

The cell called "number of sites" refers to how many different sites the end customer has the intention to install the W9L20 containerized power plants on. Costs that are affected by this cell are costs related to engineering, documentation and tools. There needs to be one set of tools per site, one engine manual per engine and one station manual per site. Engineering is affected due to that all sites are unique.

The final cell, called “NOx limitation” refers to the NOx optimization of the engine. There are two choices behind this cell and cost of the engine is affected by a small portion depending on which configuration the user selects.

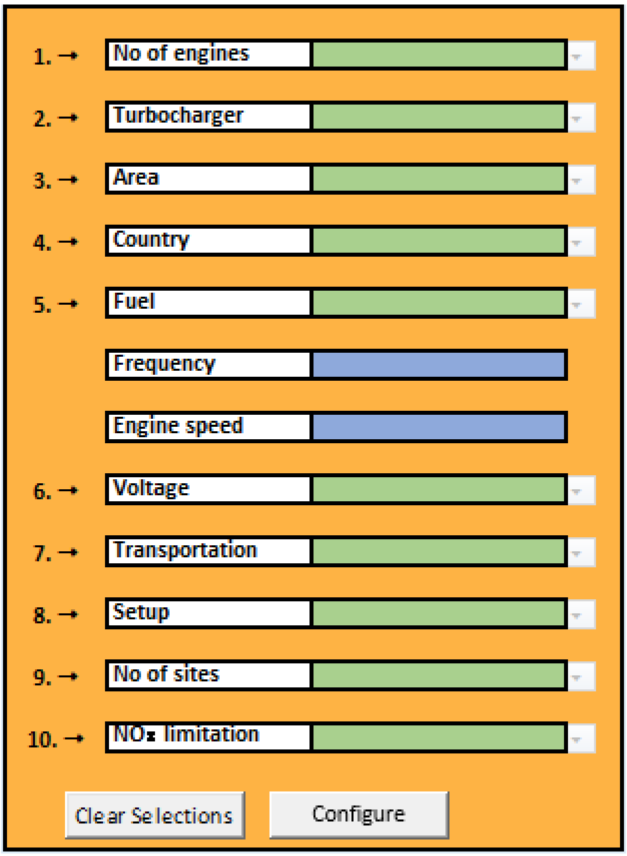

Figure 13: The configurable part in the sheet called “Start here”. The green cells have options behind them. The blue cells change automatically depending on chosen options.

The button with the caption “Clear Selections” does exactly what it states, it clears the options the user has chosen before. The button was done by inserting a command button (active X) in excel. The button was then coded so that it clears the data in the cells with a choice behind them (the green ones).

The button with the caption “Configure” takes the user to the next page in the tool, called “Summary”. The button was made the same way as the “Clear Selections” button. The button does not allow the user to continue to the next page unless all options are selected. If the user pushed the button, and has field unfilled, the tool gives the following message: “Fill out all fields". The user then has to fill out all required fields in order to continue to the summary page.

5.2 The summary page

All of the costs described in chapter 4 are worthless if they are not gathered into one place in the tool which adds all of the costs together, to show a final estimate sales price to the user. All of the costs described earlier are collected to a sheet called "Summary" in the tool.

The quantities of the physical equipment are determined by the number of chosen engines in the first sheet in the tool, called "Start here". Costs of these items are gathered from two sheets, depending on in what container they belong (auxiliary or generating set container). The equipment related to the generating set container are gathered from a sheet called "GensetContainerCost" and the equipment related to the auxiliary container are gathered from a sheet called "AuxContainerCost". If the user however configures the solution to be run on light fuel oil there is only need of one container. The costs and quantities of the equipment are then gathered from a combination of both sheets.

The summary page is divided into different sections beginning from A and ending at K. Sections get their starting letter depending on what is included in that section. The "A" section includes all physical items, rest of the sections are non-physical items such as project management services and engineering.

Section	Description	Own QTY	QTY	Responsibility	Own Cost/QTY
A1.5	COMPRESSED AIR SYSTEM				
	Starting air bottle		0		
	Starting air compressor unit - single		0		
	Piping and valves compressed air system (set)		0		
	Compressed air interconnections between containers		0		

Figure 14: Leftmost part of section A1.5 in the summary page.

Cost/QTY	Total cost (I)	Markup (%)	Cost after markup (I)	Total sum for section (I)
				#VALUE!
Choose responsibility	#VALUE!	0%	#VALUE!	
Choose responsibility	#VALUE!	0%	#VALUE!	
Choose responsibility	#VALUE!	0%	#VALUE!	
Choose responsibility	#VALUE!	0%	#VALUE!	

Figure 15: Rightmost part of section A1.5 in the summary page.

In figure 14 the column named “QTY” is populated automatically depending on how the user has configured the start page of the tool. In cases where the user wants to put in a different quantity that what the tool automatically configures the user has the possibility to fill in cells in the column called “Own QTY”. The tool uses these quantities then instead of the values in “QTY”. For example: the user has configured a plant consisting of one solution. Section A1.5 is then populated by certain quantities of certain equipment, however the user wishes to change the quantities, he or she then types the preferred quantities in the cells under column “Own quantity”.

The column called “Responsibility” has a drop down list behind it. The options from the drop down are “Customer” or “Wärtsilä”. In the tool this means who has the responsibility for the equipment on that row. If the user chooses the option “Customer” the tool calculates with zero cost, if the user chooses the option “Wärtsilä” the tool calculates with the actual cost of the item in the selected row.

The column named “Cost/QTY”, in figure 15, is automatically populated the same way as the column “QTY” only that in this case costs are gathered from two separate sheets. If the user however wishes to enter an own cost of certain items this is done by entering a value in a cell in the column named “Own Cost/QTY”. The program then uses that value instead of the original, automatically populated value.

The column named “Total cost (€)”, in figure 15, shows the total cost for that row. For example: we have five starting air bottles, let us say that the cost for each is 5000 €. The cell under the column “Total cost (€)” then shows the value 25 000 €. But if the user has put an own cost of 6000 € for the same number of bottles the cell then shows 30 000 €.

The two following cells under columns “Markup (%)”, and “Cost after markup” lets the user mark the price up with a chosen percentage and the tool then adds that percentage to the cell under the column “Total cost (€)”. The column named “Total sum for section (€)” shows the total cost for a specific section by adding separate costs together. The bottom of the summary page shows the user the final sales price. Here additional tweaks can be done, if the user sees the need to do so.

In the rows located at the top of the summary page is a button with the caption “Scope of Supply”. When pressing this button the tool writes out a sheet from the tool into a word file. There are two sheets in the tool which can be written out when pressing the button. These are named “Scope of supply (HFO)” and “Scope of supply (LFO)”. Which sheet the button writes out into a word file is determined by the choice of fuel at the start page of the tool.

Figure 16: The "Scope of Suppy" button.

The two sheets which the button shown in figure 16 populate automatically depend on the choice of fuel at the start page. If the user chooses light fuel oil as fuel the sheet named “Scope of supply (LFO)” is populated, and otherwise if the user chooses heavy fuel oil.

Section	Description	Qty	Responsibility of Wärtsilä	Responsibility of Customer
A	**POWER GENERATION**			
A1	**GENERATING SET CONTAINER**			
	Each generating set container includes the following equipment:			
A1.1	CONTAINER STRUCTURE AND ENCLOSURE			
	40ft container, high cube	1	X	
	CSC certificate	1	X	
	Furnishing of containers	1	X	
A1.2	GENERATING SET			
A1.2.1	ENGINE			
	Wärtsilä 9L20 engine	1	X	
	Turbocharger (type)	1	X	
A1.2.2	GENERATOR			
	Generator (voltage)	1	X	

Figure 7: Part of a populated word file from pressing the button shown in figure 16.

The responsibilities in the scope of supply gets populated with an “X” depending on what responsibilities the user has chosen for each item in the summary page. In figure 16 the user has chosen all of the listed items to be under Wärtsilä’s responsibility. The population of the sheets named “Scope of supply” where done by simple IF-statements in excel. The button “Scope of Supply” was done with the help of Visual Basic. What should and should not be included in the scope of supply was determined by earlier done offers and by the help of my colleagues at Wärtsilä.

6 Conclusions

The following chapter tells the reader my own opinions of the achievement with this thesis. It tells the reader how well I believe the result corresponds to the given task, what could still be done with the Excel based tool and problems that occurred during the making of this thesis.

Looking at the results, my opinion is that the results fulfil the given task. A working product configurator has been made to quickly give a budgetary sales price of a containerized plant. Since the tool automatically exports scopes of supply from Excel to Word the user gets less manual work, which would be the case otherwise. Now employees at Wärtsilä have the possibility to quickly create proposals for a W9L20 containerized power plant.

Creating tools of this kind is very time consuming, even more so if the creator is not the best at using Excel. The scope of this thesis could have been bigger. The tool could have included crude oil as a fuel alternative but also smaller engines as possible choices, such as the W6L20.

6.1 Problems

Even if a working tool has been created, the road to the final product was not without obstacles. The first error I myself made was the choice to completely build the tool in Excel's visual basic (VBA). I am a little familiar with programming in VBA from the past, however I soon noticed that my knowledge was far from enough to build a tool of this kind. I then decided to build the tool by mostly using IF statements. Instead of using ActiveX combo boxes I used Excel's data validation boxes for the start page of the tool. A bunch of ActiveX boxes were programmed in VBA before I understood that using this method is far too complicated and is too time consuming.

6.2 Further improvements

As mentioned in chapter 7 the tool could have included the choice of crude oil and smaller engine types. The tool could also let the user choose to configure a dual fuel version of the W9L20 engine.

Since costs of every single item in the complete solution has not been verified and looked up, this could also be done. However prices are not fixed and to have updated prices of all items included in the solution would require continuous look-ups of these items. Detailed lists of engine parts could be presented on a separate sheet. That way the user of the tool could manually look up the parts, if the users sees the need to do so.

As we know by now, the tool was built in excel. However the whole tool could be built into another platform, perhaps into Wärtsilä's customer relations management system.

Additional buttons could be built into the tool. The functions could be to automatically write a technical specification of the configured solution and an actual proposal written by Wärtsilä standards.

6.3 Final conclusions

I have learnt lots from doing this thesis. Not only have I developed my skills at using Excel but I now have a better understanding of power plants in general, especially containerized ones.

I want to thank my supervisors Mikael Ehrs at Novia and Tom Lindqvist at Wärtsilä for helping me finnish this thesis and providing guidance on the way.

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