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DEVELOPING PRE-EXECUTION PHASE ACTIVITIES TO IMPROVE SHIP DESIGN PROJECTS SUCCESS

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TIIVISTELMÄ

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Toteutusta edeltävän vaiheen toimien kehittäminen laivasuunnitteluprojektien onnistumisen parantamiseksi

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Kaupallisesti kannattavien suunnitteluprojektien toteuttamiseksi, insinööritoimistot ovat erittäin riippuvaisia myyntivaiheen aikana saatavilla olevista tiedoista ja siitä, miten sopimus määritellään. Kilpailu etenkin laivasuunnitteluprojektien saralla kasvaa tasaiseen tahtiin ja yrityksillä on enenevissä määrin käytössään resursseja edullisempien kustannustason maista jolloin he pystyvät tarjoamaan huomattavasti aikaisempaa alhaisempia hintoja, mikä lisää hintakilpailua. Kalliimpia resursseja omaavien yrityksien on näin ollen erittäin tärkeää pystyä varmistamaan, että kaikki kivet on käännetty, jotta resursseja voidaan käyttää täydessä potentiaalissa. Projektin elinkaari ja siihen olennaisesti liittyvät mahdolliset ongelmakohdat, on hyvin laaja kokonaisuus yhdessä tutkimuksessa käsiteltäväksi joten on parempi arvioida parannuskohteita vaihe vaiheelta. Diplomityö tehtiin yritykselle, joka tarjoaa asiakkailleen laivasuunnittelupalveluita. Tavoitteena oli tutkia, että mitä mahdollisia haasteita havaittaisiin projektien toteutusvaiheessa ja mitä havaituista haasteista voitaisiin mahdollisesti ottaa paremmin huomioon jo toteutusta edeltävässä vaiheessa. Tutkimusalueeksi kohdennettiin prosessi sen jälkeen, kun tarjouspyyntö on vastaanotettu siihen asti, kun sopimus on allekirjoitettu ja siirrytty projektin toteutuksen käynnistämiseen. Markkinointia ei sisällytetty tutkimuksen piiriin. Nykyistä ISO-sertifioitua johtamisjärjestelmää tarkasteltiin, jotta ymmärrettiin, miten prosessit nykyisellään ohjasivat työn tekemistä. Tätä seurasi teoriakatsaus, jossa selvitettiin toimintaympäristö missä laivasuunnitteluprojekteja toteutetaan. Lisäksi neljän case-projektin avainhenkilöiden haastattelut ja niihin liittyvän projektidokumentaation tarkastelu olivat keskeisiä laadullisen tiedonkeruun lähteitä. Tulosten perusteella voitiin päätellä, että lyhyen aikavälin taktiset tavoitteet ovat oleellisia mittareita suunnitteluprojektien onnistumisen arvioinnissa. Kriittiset aiheet, joita voitaisiin käsitellä paremmin jo ennen toteutusta, liittyivät 1) kustannusten laskentaan, miten seurataan, että laskentaperuste ei muutu toteutuksen aikana 2) sopimusmäärittelyt, miten varmistetaan suunnittelun edellytykset myynnissä oletetulla tavalla ja 3) sidosryhmät, miten varmistetaan, että kriittisten sidosryhmien toimet ymmärretään etukäteen. Tuloksien perusteella ehdotettiin, että olisi oltava selkeä prosessi, jossa otetaan huomioon tiedonsiirto myynnistä toteutukseen, ja lisäksi prosessin ohjaus olisi integroitava nykyiseen CRM järjestelmään siten, että voidaan varmistaa, että korostetut asiat saavat riittävän huomion toteutusta edeltävässä vaiheessa.

ABSTRACT

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Developing pre-execution phase activities to improve ship design projects success

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79 pages, 34 figures, 7 tables and 4 appendices
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M.Sc. (Tech) Ray Essen

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To be able to offer and execute commercially feasible projects, consulting and engineering companies are highly dependent on the information that is available during the sales phase and finally how the contract is defined. Competition within ship design projects is increasing at a steady pace. The amount of companies having resources from lower cost countries are increasing the price competition while being able to offer significantly lower hour rates. With higher cost resources it is therefore extremely important to be able to ensure that all stones are turned to be able to use the resources for their full potential. The whole project lifecycle and all relevant aspects is rather extensive to cover within this type of research it's better to evaluate areas of improvement phase by phase. This master's thesis was done for an company offering ship design services for its customers. The objective was to investigate that within ship design projects, what issues noted during the execution phase, could already be taken into account during the pre-execution phase, to ensure that impact on future projects success would be minimized. The focused area for improvement was the process after the point when the request for quotation was received until the point when contract was signed and project execution was initiated. Marketing activities were not considered. The existing ISO certified management system was first reviewed to understand how the processes guide current way of working. This was followed with a theory review to explain the environment ship design projects are executed within. Four case projects were selected to understand actual way of working. Interviews with key employees and reviewing related project documentation were main qualitative sources for data collection. Based on results it was concluded that short term, tactical objectives are most relevant when evaluating design projects success. Critical topics to be addressed before execution were related to 1) cost calculation, how is it monitored that the basis for calculation does not change during execution 2) scope and guidance definitions, how to ensure that design prerequisites are as assumed and 3) stakeholders, how it is ensured that the actions of critical stakeholders are understood in advance. As a solution it was proposed that there should be a clear process to take the information transfer from sales to execution into account and then the process guidance should be implemented into the existing tools to enable a systematic way to ensure the highlighted issues are taken into consideration during the pre-execution phase.

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1 INTRODUCTION

This thesis was done for a case company's business unit offering consulting and engineering services for the maritime industry. Focusing on ship design related projects, the thesis's main objective was to search for possible issues that cause these projects to perform in a unsuccessful manner, issues which could be mitigated before the project execution is initiated.

1.1 Motivation

Projects are very common in the shipbuilding industry. Whether you are the yard responsible of building and designing the whole ship or a consulting and engineering firm executing parts of the larger scope the work is usually executed as projects. Many key decisions are made during the sales phase and the project contract and its appendices serve as final documentation to summarize the agrees matters. However even though the parties involved in the sales phase understand what is in question it doesn't guarantee that the parties in following phases understand everything the same way. During the years competition within the maritime consulting and engineering business environment, has increased. Potential customers have more design suppliers to choose from. At the same time it can be noted that traditional guidelines as specified in literature are not any more followed similar way as previously.

For example considering project pricing methods, fixed price contracts are described as feasible alternatives if the project scope specification is clear with limited margin to deviate (Artto, Martinsuo & Kujala 2011, p. 70). However possibly due to decreasing amount larger project opportunities and at the same time increasing amount of global consulting and engineering firms with free resources, in addition to pushing the prices down, the customers have more leverage to transfer more risk to suppliers by requiring contract types which should traditionally be used for less riskier projects. Therefore it becomes essential that the background and motivation behind each project contract is transferred to the execution phase as detailed as feasible.

1.2 Research problem

If the knowledge transfer is done in a sufficient manner and yet projects are performing unsuccessfully it is critical to evaluate the root cause of those issues that the project execution is running into and that could there be something that could be done in different way already during the sales phase. Based on initial literature review regarding project sales and project execution in general and how earlier research has evaluated the knowledge transfer and/or communication within the interface, analysis about the topic especially in the ship design domain was not found. Rather it seems the sales is seen as a own expertise area and project execution as its own. For example when evaluating reasons for failed projects, the focus is on how the project management could have been done in different manner, rather than considering the aspect what could have been differently before the project was even started. The case company, has a management system with some common process guidance for all business units regarding how to handle the transition, but comparing for example ship design projects and construction projects, there are of course some similarities, but after going deeper, what works in one business area doesn't necessarily mean it works in another (Artto et al. 2011, p. 13). After discussions with senior management there can be noted a need to evaluate the current way of working within the interface.

1.3 Research questions

To clarify the main objectives of this thesis, the following research questions have been defined, including a short explanation how the question is planned to be answered:

1) **When projects fail to succeed during execution, what common issues can be highlighted, which could be taken in to account in the pre-execution phase?** The answer to this question will mainly be based on the findings and analysis from interviews. In addition any available documentation related to the projects will be reviewed and used to back-up the claims raised in the interviews.

2) **How could the current process be developed to take the highlighted issues into account?** To answer this question, it could mean that for example if issues are generally noted in communication, the current process would be analyzed from that perspective, based on findings proposal for improvement would be introduced.

3) **Could the sales and project management software utilization be developed to improve the process?** It is known that the case company has several sales and project management software in use during the process and one interesting point is to understand what the current process actually requires and how well is it supported by the common software. For example does the process guide to use specific tools in a similar manner each time or is more up to the users to select what to use.

1.4 Applied research methods

To be able to gain a sufficient overall understanding of the current way of working e.g. what is expected to be done by processes and what is actually done, a qualitative research approach has been selected. Semi-structured interviews are the primary source of information while process and project related documentation is the secondary source. To be able to define a structure for the interviews and highlight possible experiences from earlier research a literature review about ship design and project management theory will be conducted in advance. Additional theory will be introduced based on the results of interviews (figure 1)

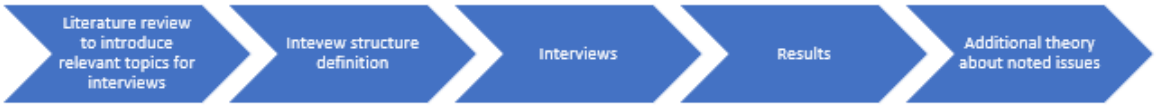

Figure 1. Theory usage.

To summarize, besides supporting literature, following data sources are used to answer the research questions:

- Current management system process documentation
- Answers from theme interviews
- Projects documentation, financial statistics, reports etc.
- Own professional experiences and observations

1.5 Scope

In this thesis the so called pre-execution process is limited to the process after a request for quotation (RFQ) is received, until the potential project execution kick-off is arranged. This means that marketing activities will not be considered. The internal project kick-off arranged by the project management personnel is considered to be the end point of this thesis (figure 2). However the project execution phase needs so therefore the process will be introduced further on until the kick-off of the actual project execution phase.

Figure 2. Thesis scope, pre-execution phase process.

One, maybe obvious, limitation is the fact that the thesis covers ship design projects within the maritime industry. Information about different type of ship design projects and how they can be classified will be introduced later on. However the aim is to find and analyze projects with similar classification to be able to find matters that are repeating and be able to do comparison. When talking about the maritime industry and the case companies project portfolio within this environment, further reason to focus on ship design projects is the fact that these are currently projects with most value and therefore more impact on company financials if something goes wrong. Finally as projects tend to be long, several months, endeavors, measuring the actual performance of any proposed solutions will not be covered in the scope.

1.6 Contribution

As a result of this research it is expected that common issues which can be noted during the execution of ship design projects and which can be linked to pre-execution phase as something that could be mitigated during pre-execution are highlighted. Additionally the gap between requirements, what is required by the processes and how work is actually done will be understood. Taking the current process in to consideration it is then discussed how these highlighted issues could be actually mitigated and the processes developed.

2 SHIP DESIGN PROCESS

This chapter introduces the ship design process, the different phases it is divided into and the main characteristics and stakeholders of those phases. When considering the ship design process from the case companies perspective, the content of work and the environment where the work shall be executed can deviate very much depending on requirements specified by the customer. Due to very broad expertise in the marine industry, the case company can offer services to pretty much any part of the process whether it's to design a ship completely from the initial concepts or only take part in specific phases of the design.

It is common that the first steps in the ship design process are taken with a qualitative mindset. Choices are based on experiences and statistics from earlier ship designs, meaning that the initial ship technical specifications can be at a very generic level. Iteration is a common way to increase the design level of detail. Same topics are evaluated as the amount of knowledge increases. A way to visualize this is with a so called design spiral (figure 3). The amount of cycles can vary a lot depending on the complexity of the ship project in question, and it's not granted that you will always succeed. Nevertheless iteration is a good way to conclude a design is feasible or not.

Seldom is the process as straight forward as the spiral indicates but rather the point is that it is usually necessary to evaluate the same topics more than once while the overall level of detail increases. (Lamb 2004, 5-3) Once an optimum is found for one specific system, in the worst case it can mean some other system performance reduces at the same time, so finding an optimal compromise is many times the only efficient way to progress (Vossen, Kleppe & Hjørungnes 2013, p. 8). Depending on what stage the decision to involve external design suppliers the iteration process can also be noted during the sales phase. The initial information provided during first point of contact, maybe at the very beginning of the spiral, can evolve significantly while moving towards the signing of the contract, but even at time of contract signing there might be a long way to go until the information is suitable for a specific use.

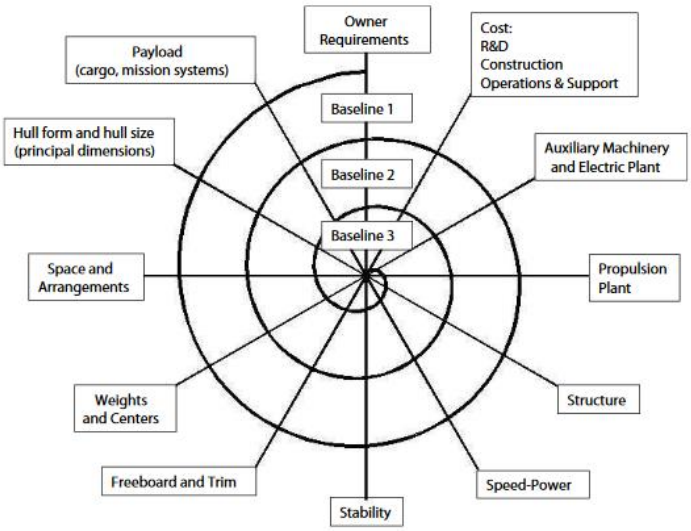

Figure 3. Design spiral (Lamb 2004, p. 5-2).

2.1 Design phases

The terms might vary depending on which source is referred to but basically the ship design process is always divided into specific phases. The division is more or less considered in similar manner, and is based on the required level of detail at different stages of the process. Also as the level of detail increases the amount of resources increases as well, for example considering a cruise ship project the amount of people starts to increase from a small group of naval architects to several hundreds of designers at the most busy stages. Within the Finnish ship design environment terms 1-4 listed below, in chronological order, are often used to classify the different phases. (Räisänen 2000, p. 30-1.)

1. Concept design
2. Project design
3. Basic design
4. Detail design

Concept design: considering a new build, the ship design process is many times initiated by the ship owner. To simplify for example the ship owner needs to replace a soon obsolete vessel. There is a route it shall operate, x times a day and needs to be capable to carry y amount of passengers. These give the very basic requirements to start with and those can be taken further by considering for example how fast and how efficiently it needs to transit from

A to B, and as a result of this analyze you have a preliminary requirement for the hull shape, engines and propulsion. To take the studies and initial specifications to a reasonable level to send requests for quotations to shipyards, the ship owner can do the work internally if sufficient knowledge is available in-house or it is possible to hire a consul like the case company to support with the work. It is also possible that ship design service providers make concepts internally by themselves based on current trends and sell readymade concepts to ship owners. The concept phase can also be referred to as a feasibility study of the requirements (Lamb 2004, p. 5-8). Like a technical datasheet, to provide technical details of a main engine, a ship specification is a document or set of documents that provide the technical details of the ship. The preliminary version of the general arrangement (GA) is a usual output of the concept phase. The GA includes the main dimensions and layout of all the decks. The initial negotiations with the shipyards are usually handled around a set of documents, sometimes referred to as a ship outline specification, which determine the baseline to start with. (Räisänen 2000, p. 31-1; Lamb 2004, p. 4-7.)

Project design: when the ball park, what kind of ship is roughly in question and capable shipbuilders have confirmed their interest, is understood, project design is the starting point to build on the initial requirements defined in the concept phase and the main objective is to be able to determine a solid foundation to start building the ship if the order is received and also for proper cost and offer calculation. In other words the project design phase work aims to determine what actual ship building methods could be used, what actual equipment could be purchased to fulfill the ship owners technical requirements, and further gain understanding what kind of suppliers are available to supply the needed solutions and services and at what cost (Lamb 2004, p. 5-8). As one result of the project design phase, the outline specification will be further developed from tens of pages to hundreds of pages of technical specification to attach with the contract to compare against the actual results and continue with basic design. (Räisänen 2000, p. 34-1.)

Basic design: this phase is usually started right after the contract is signed, i.e. when the project design is completed. Main objective of this phase is to take the contract specification details one step further to provide more actual information about how systems will function and finally get required approvals for the design. At the same time determining needed technical details about all major systems and equipment for the procurement department is

also a key task to be done during basic design. One very important input many times pending agreements with equipment suppliers is the final technical data about the equipment so that all requirements are taken into account in the design. To ensure smooth integration to ship and all other systems within, it is essential to receive the correct input at the right time from equipment suppliers. (Vossen et al. 2013, p. 9.)

In the project design phase there is usually determined a list of basic design drawings that need to be approved by the customer and also the selected classification society. The amount of drawings varies depending on the ship type for a cruise ship several hundreds of drawings are needed. When approved, these drawings provide the starting point for further design phases, the detail design phase. For example there can be a system piping diagram to show where pipes should be routed and connected and what materials should be used. Then the detail design takes that as input to actually route the pipes in the 3D ship model and creates the workshop drawings for production purposes (Räisänen 2000, p. 35-2). The concept and basic design phase related documentation are usually two-dimensional (2D) documents.

Detail design: most of the detail design related work is done in a three dimensional (3D) model. The point of detail design is to transfer the basic design arrangements and diagrams etc. into the model as actual items and finally form workshop drawings of these items so that everything can be finally manufactured and installed to create the final product, the ship. Similarly as in basic design the scope of work is determined by a list of drawings. The amount of drawings depends on the shipyards production methods. For example cruise ships are usually built from sections, also called as blocks. Sub-sections are combined to sections, sections are combined to grand sections and finally grand sections are lifted in the dock to erect the final hull (Räisänen 2000, p. 37-31). From section outfitting drawing point of view this could mean separate drawings for each section type and finally the areas which are ready once all sections are combined together. This means that the amount drawings can rather easily exceed thousands of pieces for a cruise ship. Amount of work per drawing depends on what is the required level of outfitting for those sections. Sub-sections can be upside down so it’s easy to handle outfitting as far as possible to prevent need to install anything when block is turned to correct position and scaffolds are needed to carry out any further installation, and the efficiency decreases (figure 4). So one key consideration in the detail

design and drawings is when is the most efficient time to install something. (Räisänen 2000, p. 39-4.)

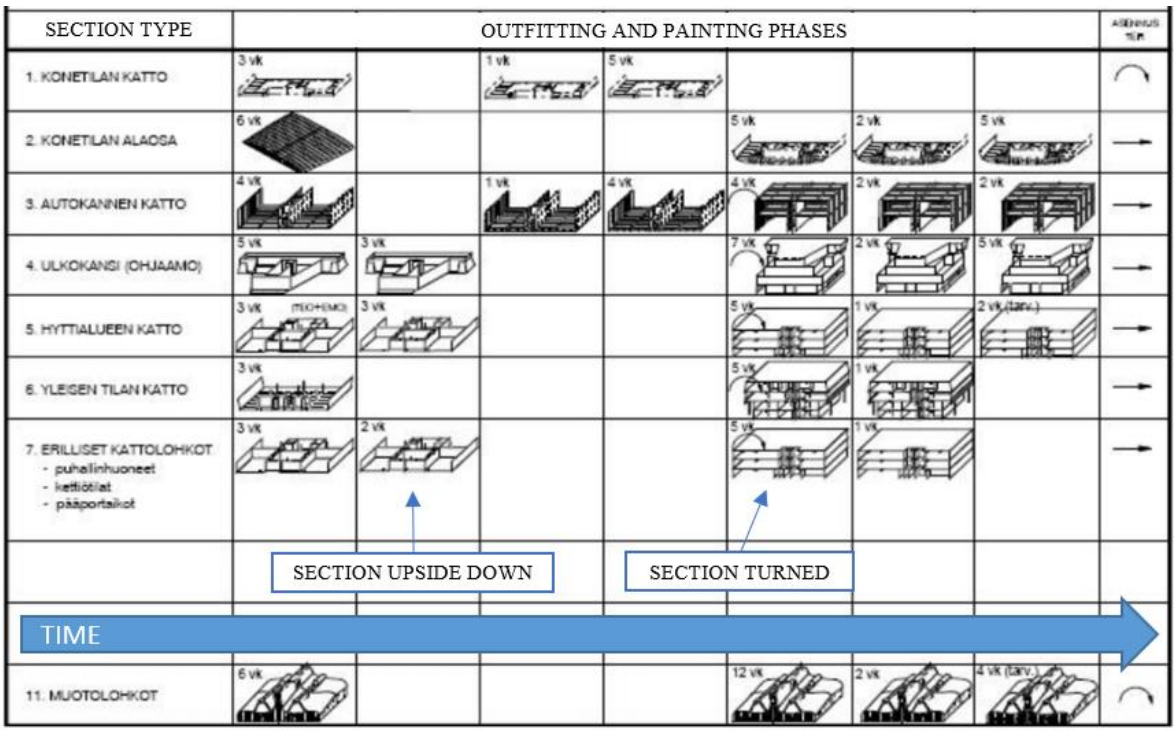

Figure 4. Section outfitting (TUAS 2010).

In theory the transition to the next phase should happen more or less when the previous phase is complete but sometimes the case is that there is overlap for example between the basic and detail design phases. This is usually because there is some critical information that needs to be provided to the production department well before it is reasonable to expect some related basic design documentation could be final. Eventually when more final information is available the previously delivered production documentation is checked for any updates and production documentation is revised if required. (Räisänen 2000, p. 36-1.)

Another example is that sometimes depending on the schedule and contract it can also be that the basic design phase is started earlier if mutually agreed with the customer. However in these cases it is usually further agreed that if the contract is not signed in the end the shipbuilder will get compensation for the basic design work done in advance. Finally it is good to keep in mind that seldom is the case such that the previous phase is 100% complete to provide straight forward input for the next phase to complete work without needing to make changes to the previous phase, iterations applies here as well. (Räisänen 2000, p. 35-1.)

It is essential to keep in mind that once the Finnish borders are crossed, and the further we need to travel to meet the customer, the more probable it is that the used terminology differs. Or the terminology might be the same but the content of work can differ compared to specifications in the Finnish ship building environment. This brings one of many twists to the sales negotiations when dealing with customers located around the globe. Keeping your fingers crossed and hoping for the best very likely ends up in bad results.

2.2 Design disciplines

In addition to dividing the design in to specific phases the designers working with specific ship and its systems are traditionally grouped to specific disciplines. These disciplines can be called for instance hull design, machinery design, deck design, interior design and electrical design. Considering the phases together with disciplines, the disciplines are divided to basic and detail design phases, like hull basic design and hull detail design. From organizational point of view the design organization is divided based on the different disciplines there exists (Räisänen 2000, p. 38-1).

2.3 Stakeholders

Regarding stakeholders within the ship design process, everything starts with the ship owner, the customer, and it is good to keep in mind the end-users and their requirements as well. Then there is the flag state which selection determines the laws and regulations that shall be followed. Shipyards get involved when the ship owner begins its evaluation for potential ship builders. Depending what the shipyard handles internally and what is done externally, this impacts the amount of different stakeholders further down the line. If the design is outsourced, there are usually several parties dividing the scope. Design suppliers can further

engage their own sub-contractors if necessary. Similar way as the design is divided in to several disciplines also the production has many sub-departments handling specific tasks like production planning, hull production, section outfitting etc. A classification society is selected to support the flag state and ensure sufficient rules and standards are followed during the design and construction phases. Equipment and system suppliers are engaged to understand how the systems integrated and installed within the ship.

To summarize the whole chapter, considering the sales and the kick-off phase of any ship design project, it is very important to understand the environment where the work shall be done, not forgetting the terminology used and what the terms actually mean. What means one thing with one customer does not necessarily mean same thing with the next customer. Therefore each new sales case and especially new cases with new customers should be evaluated as thoroughly as feasible. Assumptions should be kept at a minimum. It is good to keep a critical mindset with customers that there already exists a relationship with and projects have been done earlier. It doesn’t necessarily mean that the next project will be the same.

3 PROJECT BUSINESS THEORY

In addition to theory about ship design process, it is also important to understand what can be highlighted about the sales and project execution interface within related literature. Therefore, based on discoveries from common literature databases this chapter introduces project business theory related to the research topic. First the common project business lifecycle and environment is described, to understand different options where the case company can operate in i.e. what type of projects there exists. This is followed by further focusing on the sales of different type of projects, what possible findings can be highlighted that could be seen as key inputs to the execution phase, at the same time considering what the project management actually needs to succeed in the execution. Additionally, as the thesis aims to improve project performance it is important to understand how project success is seen and how can success be measured.

The term project business is used when talking about activities that are directly or indirectly related to projects and at the same time aiming to achieve the objectives of a company. Direct activities are activities that focus on for example specific objectives during project execution while indirect activities are activities that focus on the bigger picture how projects are prioritized as a whole. (Artto et al. 2011, p. 11.) It can be said that the scope of this thesis is mainly related to the direct activities, as one high level objective is to execute successful projects. There are various ways to divide projects into different types. For example there can be new product development (NPD) projects and various type of engineering projects for various industries. Despite what type of project, there is one common way to categorize projects based on the size of the project: small, medium and large projects. The size ranging from couple months, couple person-year projects to several years, several thousands of person-year projects. Considering ship design projects, those can be anything from hundreds to hundreds of thousands of design hours. Size and type define, or at least should define, the way the projects are managed (Artto et al. 2011, p. 13).

Figure 5 shows the differences between investment and delivery projects. Considering the ship design projects the case company is usually responsible for the delivery project. However there are many different positions the case company can be within depending what

type of design project is been delivered. The shipyards have their own delivery projects to the ship owners and the ship owners are usually the so called project owners who have initiated the main investment projects. Then again the case company can have a delivery project more directly to the main investment project, for example by supporting with the initial concept design to evaluate the feasibility of the investment project. Finally it is also possible that the case company can be the project owner of the investment project for example by designing a own ship concept to be marketed to ship owners.

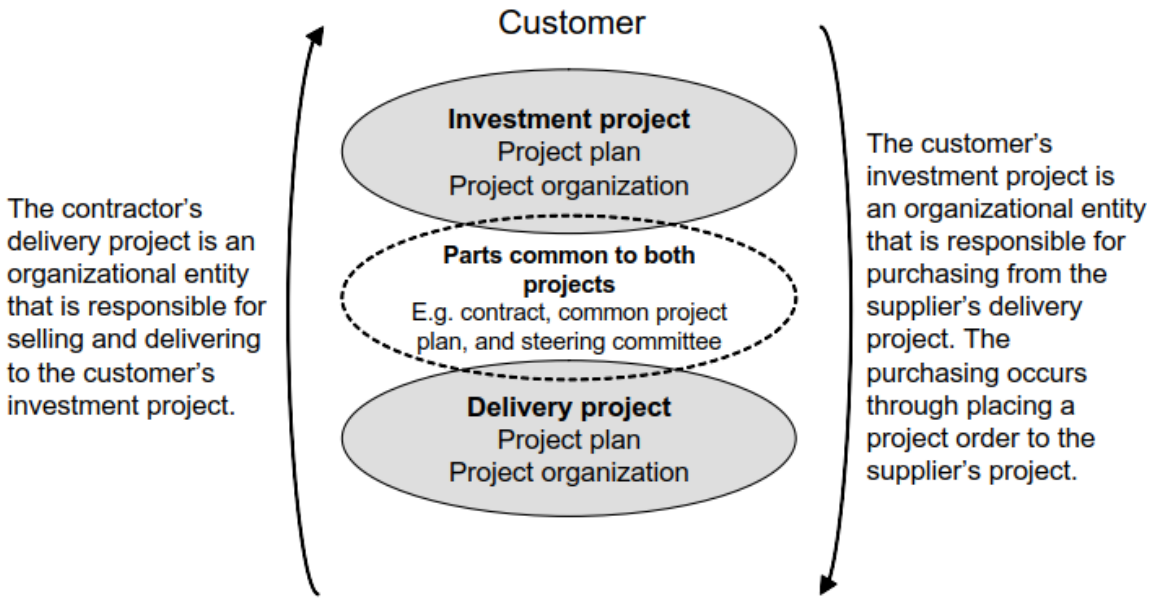

Figure 5. Investment vs delivery project (Artto et al. 2011, p. 14).

Obviously more parties between the investment project and the case company delivery project, might introduce some additional issues. To be able to execute financially feasible project business, each company usually needs to gain sufficient profit. The more there are delivery and sub delivery projects down the stream the smaller the profit possibilities usually get. Considering the size of the case company and its 100+ design resources, it is able to take part in the larger size ship design delivery projects and therefore be closer to the actual investment project.

The usual complete lifecycle of a single project starts from the initial investigations until the project is delivered to the customer and depending on the case, further support and services can be provided for the time of operation (Artto et al. 2011, p. 38). Figure 6 presents the

main phases during the project lifecycle. Depending from which actors point of view you are reviewing the actual project execution, it is different. Considering the ship design projects, those are usually delivery projects for the customers implementation phase, but it is possible that the projects include involvement in other phases as well, like providing support in planning and control. A lot depends how much the customer is able and willing to take responsibility. For example typical ship design project scope of work is a specific design work package to cover all basic and/or detail design of an area(s) or system(s) within a ship.

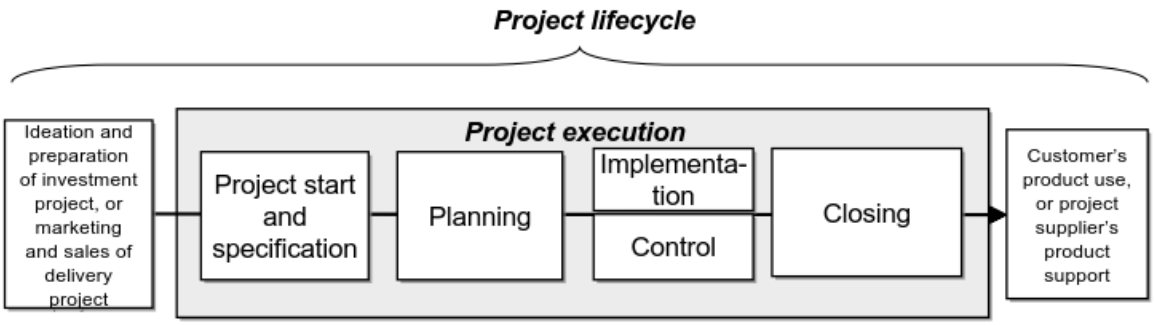

Figure 6. Project lifecycle (Artto et al. 2011, p. 38).

Projects are defined as unique and complex endeavors which have a predefined goal that should be achieved within certain time, certain cost level i.e. budget and finally according to the agreed specification which determines the scope of work (Artto et al. 2011, p. 18). Also called as project objectives: time, cost and scope are very much dependent on each other as visualized in figure 7. For example within a certain period of time with certain resources there is a maximum effort you can do. If you want to reduce time then that could mean you need to add more resources and increase the initial costs and/or reduce scope of work (Artto et al. 2011, p. 25). The starting point is about finding the right balance but when the balance is found and the foundation for project execution is decided, any alterations later on to any of these objectives is likely to cause the need to re-evaluate the situation. This is very much linked to the sales phase of projects as it is possible that some or all of these three objectives can be more or less tied up during the negotiations depending on how the negotiations are taken care of.

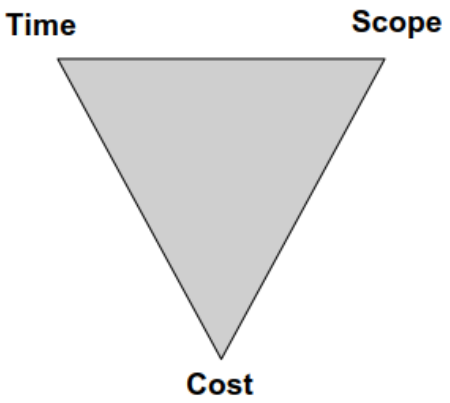

Figure 7. Project objectives (Artto et al. 2011, p. 23).

To successfully reach its goal, a project needs to satisfy the set expectations and requirements. This is one of the key challenges in project planning and execution. The various technical, social and financial factors impacting the environment where projects are executed require appropriate and systematic management practices and methods to increase the probability of reaching the project goal with successful results. Project management as a definition includes all management activities targeting that the projects goal and objectives are achieved successfully. However it is very essential that the goals and objectives are defined in an adequate way. (Artto et al. 2011, p. 26.)

3.1 Project management

There are different characterizations how project management can be considered. One common way is to divide project management in to specific knowledge areas and processes. The division to knowledge areas is based on what is seen critical for project success and what topics are logical to handle separately as an group. The project management knowledge areas, including a short introduction, are listed below (Artto et al. 2011, p. 29):

- Integration management: activities ensuring that all the pieces are tied together and that right tasks are done at the right time. Change management is also covered under this area.
- Scope management: activities ensuring that the deliverables, like design documentation, fulfill the defined requirements

- Schedule management: ensuring that the work needed to design the documentation is divided to sufficient work packages and that the packages have accurate durations and finally deliveries are made on time.
- Cost management: activities ensuring that the defined budget is followed.
- Resource management: activities ensuring that sufficient resources are available as per defined in schedule management.
- Communication management: ensuring all stakeholders have sufficient information on-hand.
- Risk management: evaluating and mitigating potential risks.
- Quality management: ensuring that sufficient quality assurance is in place.
- Procurement management: activities related to procurement for example of external resources like subcontracting

Basically the project plan is one essential document that covers all of these areas and all of them can be seen highly relevant within ship design projects (Artto et al. 2011, p. 88).The knowledge areas are seen as important factors to the project success and at the same time very much dependent on the requirements that the sales and project contract have defined. Therefore once we move forward to project sales theory and interviews, these knowledge areas will be kept in mind to see how they are actually considered before project execution.

3.2 Sales of projects

The project sales phase can also be considered as the pre-project, covering all activities from early marketing until the contract is signed and execution takes over. (Savolainen & Ahonen, 2015, p. 94). Even though most of the actual project management activities begins after the contract is received and the execution is initiated, the main boundaries regarding cost, scope and time can be defined during the sales phase (Artto et al. 2011, p. 44). As projects are unique and complex it is quite impossible to define a one-for-all process to ensure that every time all possible issues are considered systematically when new projects are introduced. One way to improve the success rate could be to introduce modular process architectures to take the key variables into account (Hellström & Wikström 2005, p. 1). For example within ship design projects gather the most important similarities from previous projects and have a modular process to ensure those are taken into consideration in future opportunities.

While evaluating what information there is available during the sales phase and how it is initially handed over to the project execution, Savolainen & Ahonen (2015, p. 92) highlight potential issues in the knowledge transfer process within their research. There are two type of knowledge acquired during the sales phase, tangible and intangible knowledge, both of which are seen necessary to execute projects successfully. Tangible referring to anything written down in the documentation and intangible referring to personal observations from discussions with customers for example. Thus it is quite impossible to transfer all of the knowledge by handing a folder full of documentation to the project manager and expect best possible results. Based on this they highlight the importance of having the project manager responsible for execution, involved already during the sales phase, even though it still doesn't guarantee that all necessary information is still transferred. Obviously one issue in having same project manager all the way from sales phase, is that it decreases the efficient use of resources. (Savolainen & Ahonen, 2015, p. 92-102.)

It is also good to keep in mind the current sales environment, what are possible environmental factors that are evolving and impacting the sales process. For example during the years as projects have become a common way to do business, at the same customers have invested in gaining better knowledge about sourcing of projects. Therefore in addition to increasing amount of project suppliers there is increasing amount of professionalism within customer organizations that customers can use to get more benefits out of the project contracts. For example this can be seen in increasing amount of financial risk that is transferred to the project suppliers. (Jalkala, Cova & Salle 2010, p. 128.)

Basically the project contract is the document that describes how the responsibilities and risks are distributed between the customer and project supplier. The greater the risk and amount of uncertainty the higher the price can be expected. Depending on the amount of risk, there can be selected suitable contract types based on the pricing method. As a rule of thumb the more accurately the scope of work can be defined the more fixed the price could be. In the other hand the more there is open questions foreseen in the project execution then a cost-plus type of pricing is seen beneficial. For example from customer perspective it is not seen as a feasible alternative to try to request a fixed price contract with a vaguely defined scope of work, as it will very likely cause the supplier to offer its services with too high price. (Artto et al. 2011, p. 70.) These guidelines are of course recommendations and what

is finally selected is a sum of several technical and financial objectives, but whatever is selected to the final contract, the project management approach would need to be aligned accordingly. To succeed, a fixed price contract requires a very different approach than a cost-plus contract. One further issue around the price is that what is finally included in the scope of work with a specific price. As noted by Merideth and Mantel (2009, p. 245) there are cases where the sales has agreed to include some additional work, that turns out to be difficult to deliver according to requirements. Thus any additions to scope should not be agreed on before the impact on time, scope and cost are carefully evaluated (Artto et al. 2011, p. 55).

The project contract and its appendices can be considered as critical documentation to be handed over from sales to the execution phase. Clear information about scope, responsibilities of relevant parties, risks and pricing are essential inputs for the project team to continue with further planning. Of course the clarity depends a lot how much joint effort is allocated to contract preparation together with the customer and furthermore there might not be exact details about some matters available which therefore need to be specified in a more flexible manner. In addition, especially in fixed price contracts, it is necessary to have the fundamentals specified about how possible modifications and changes to the agreed work scope shall be handled, and if possible to determine, also some standard pricing for the modification work. (Artto et al. 2011, p. 74.) Bid and contract reviews, also required to achieve ISO 9001 certification, are essential checkpoints to verify that the scope, cost and schedule are well defined to deliver the project successfully. Latest in the contract review it is recommended to involve personnel that are expected to be in charge of the execution. This is a good way for the sales to gain final insight from execution point of view before signing anything binding. Of course if the project manager has been involved in the sales phase then this might not be necessary, but in the other hand getting a outsiders opinion might bring up new views to the topic. (Artto et al. 2011, p. 78.)

The project plan can be highlighted as a central document to gather all essential matters together for the project execution. However even though it is noted as a tool for the execution phase, it would be recommended to start working on first drafts already during the sales phase. In addition it would be good to include the customer in the work as well. Of course the project plan can include sensitive information about project supplier but those parts could be hidden and focus could be directed to the parts that are important for all parties. For

example one of the most essential tasks involving all stakeholders is communication. Expectations in communication could be raised already in the sales phase, so it could be possible to agree some basic practicalities already in the contract and have them drafted in the project plan. (Artto et al. 2011, p. 87.)

3.3 Measuring project success

To be considered a success, a project can be assessed from many different aspects. For example it is possible that the supplier can consider a project as a success at the same time when the customer considers the exact opposite or vice versa (Shenhar, Dvir & Levy 2001, p. 714). Obviously when all parties agree it is a success then it could be rather safe to the project has been a success. Or could it? If you consider the whole lifecycle of one project and its outcome and at the same time the amount of different aspects during that time makes it actually quite impossible to define a project as a success with 100% confidence, at least before the end of the lifecycle. For example the ship design suppliers project manager can evaluate project success level depending if the project is done within set budget, in time and with agreed specifications or not. The customer, for example the shipyard, can evaluate success how efficiently it is able to build the ship. The ship owner is interested in the performance, like low fuel consumption, and end user satisfaction on-board the ship. So it's safe to say there are different ways to assess success depending on what point of view you review success from.

As visualized in figure 8 one way to evaluate success is to consider it from a tactical and strategic performance point of view. Tactical performance takes into account short-term objectives, like meeting cost, time and quality targets, in other words mostly project management related objectives. Strategical performance takes into account the long-term objectives considering the project lifecycle from a more broader perspective. As the case company role is often being the project supplier it could be expected that the tactical performance is a key success indicator and the party owning the actual investment project can better evaluate the success in the bigger picture. Of course the used design methods and for example how the design documentation to build a ship is produced, can have a major impact on how for example the ship performs during its operation phase and therefore decrease or increase the sustainability aspect (Samset 2013, p. 14). However the question how much there is possibilities to impact the design depends, among other things, a lot how

the scope of work is defined. For example the scope can be specified in a very detailed manner with very specific design guidance, meaning that there is limited possibilities to have an impact to the results. It might also be the exact opposite, so that the customer actually requires the supplier to use all its professionalism to do the job.

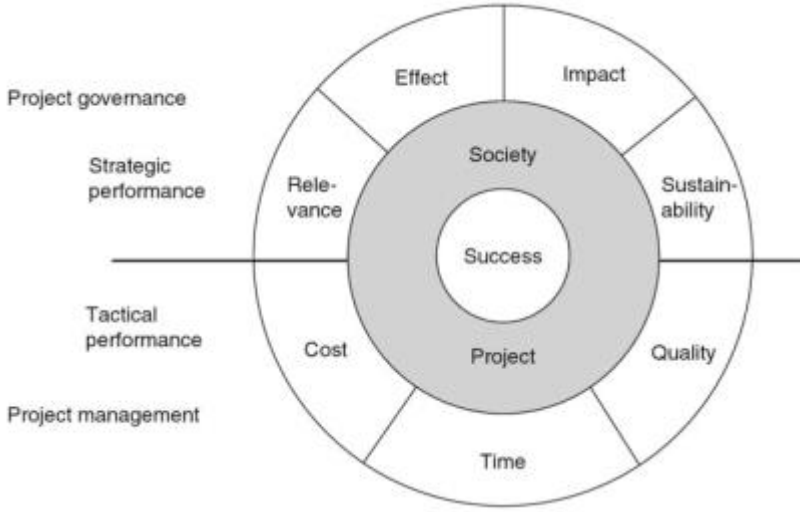

Figure 8. Tactical and strategic success (Samset 2013, p. 14).

Introduced by Shenhar et al. (2001, p. 705), another possibly better way from case companies point of view, could be to assess success based on different success dimensions. After reviewing 100+ projects and their project managers Shenhar et al. (2001, p. 705) have come up with four common success dimensions to divide success evaluation based on when it can be measured during project lifecycle. The four dimensions are called: project efficiency, impact to customer, business success, preparing for the future (figure 9). In addition, to conduct the assessment, there is highlighted key measures for each dimension. (Shenhar et al. 2001, p. 705.)

Success dimension	Measures
1. Project efficiency	Meeting schedule goal
	Meeting budget goal
2. Impact on the customer	Meeting functional performance
	Meeting technical specifications
	Fulfilling customer needs
	Solving a customer's problem
	The customer is using the product
	Customer satisfaction
3. Business success	Commercial success
	Creating a large market share
4. Preparing for the future	Creating a new market
	Creating a new product line
	Developing a new technology

Figure 9. Success dimensions (Shenhar et al. 2001, p. 712).

Similar as earlier defined as tactical performance, the project efficiency dimension evaluates the short term success i.e. how was the project completed in time and within specified budget and quality. However it is to be noted that succeeding in this dimensions alone does not necessarily mean success in the bigger picture. The second dimension, impact on customer, is about how well customer satisfaction is reached. Fulfilling performance requirements can be raised as one of the most important measures of success within this dimension. Considering the ship design environment this could mean that if involved in the concept design phase, the selected technical solutions ensure a cost efficient operation phase. Or if involved in more traditional detail design, the produced documentation ensure clear instructions for the production to follow and ensure efficient material consumption.

The third dimension, business success, evaluates success from commercial perspective, considering the question that did the project deliverable perform financially as expected after completion. If acting as project supplier, this dimension is more related to the investment owner and for example how the ship owners end customers perceive a new cruise ship, but obviously is an important matter for all parties to gain positive references if the product ends up being commercially successful. The fourth and last dimension, prepare for the future, takes into consideration how well the organization is able to gain competencies which could be seen valuable in future projects. For example the case company customers projects especially those involving more high-tech solutions development, can introduce valuable opportunities to develop own skills that can be seen useful in the future. Figure 10 represents the success dimension with respect to time. Project efficiency can be evaluated pretty much

immediately upon completion while it can take years to evaluate whether for example some skills achieved during the project turn out to be useful. (Shenhar et al. 2001, p. 714-716.)

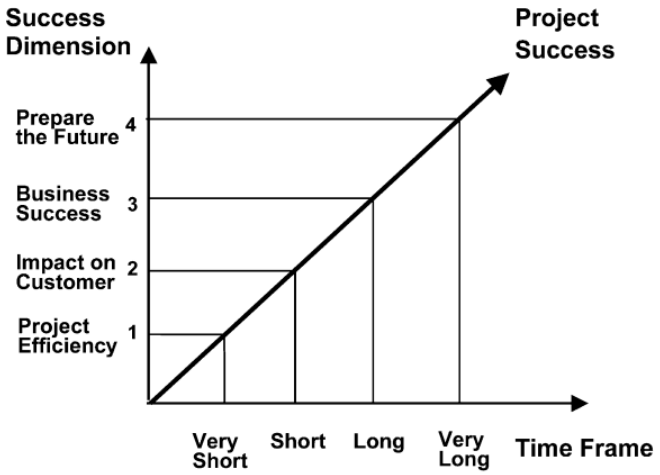

Figure 10. Success dimensions with respect to time (Shenhar et al. 2001 p. 716).

Finally it is good to keep in mind that as projects can differ in many domains, like size, complexity, technology etc., this can have an impact on the importance of different success dimensions. Within Shenhar et al. (2001, p 719) research, they chose to group different projects based on the level of technological uncertainty. With this type of grouping (figure 11) it can be seen how the importance varies between different success dimensions.

Success dimension	Project type: level of technological uncertainty			
	Low-tech	**Medium-tech**	**High-tech**	**Super high-tech**
Project efficiency	Critical	Important	Overruns acceptable	Overruns most likely
Impact on customer	Standard product	Functional product, added value	Significantly improved capabilities	Quantum leap in effectiveness
Business success	Reasonable profit	Profit, return on investment	High profits, market share	High, but may come later Market leader
Preparing for the future	Almost none	Gain additional capabilities	New product line, new markets	Leadership—core and future technologies

Figure 11. Success dimension evaluation (Shenhar et al. 2001, p. 719).

To summarize, this chapter has introduced main characteristics of project business described within the ship design projects environment. There are various positions within the ship design environment that the case company can be acting as a project supplier. In addition even if the environment would be same or similar, the projects can differ in other domains like cost, scope and time. The ship design projects have similar type of basic needs for execution as any other project type. Maybe some are not relevant but getting an answer to this, what is relevant and what is not is one of the key objectives of the interviews. It is also interesting to find out how success is considered. Is it more about the short or long term success.

4 CASE COMPANY CURRENT MANAGEMENT PROCESSES

The case company in questions offers a wide range of consulting and engineering services for several different industries. Services can include anything from developing a new product to more straight forward design services to support a customer in a specific part of some design. In addition the company has also a self-developed product portfolio to offer to its customers. Digitalization is valued very high in the company's long term strategy and the aim is to be a forerunner in this area in the companies areas of expertise, therefore new service and product possibilities are evaluated constantly. Whether internal or external assignments in question, most of the work is executed as projects. Therefore any new improvements aiming to increase project performance, are seen as valuable possibilities.

To be able to provide a baseline for development, the current state needs to be understood first. Therefore the focus of this chapter is to investigate what common procedures and guidance to handle work there currently exists. The case company has an SFS-EN ISO 9001:2015 certified integrated managements system (IMS), which covers all main processes. The IMS objective is to provide harmonized guidance for all company business units to execute projects in a feasible manner. The three main processes as visualized in figure 12, also highlighted as case companies core processes, are the foundation for the IMS. In addition to these core processes there are supporting processes for functions like IT and finance etc. The core process have their own specific documentation to provide further details about what should be the actions when operating within these core areas. For example within the project management process there is an explanation about what are the following actions when the RFQ has been received. Attention is focused to the areas relevant for this research, investigating how the sales and execution phases are defined and especially how they are integrated. Therefore the customer and project management processes and how they are interacting together are reviewed.

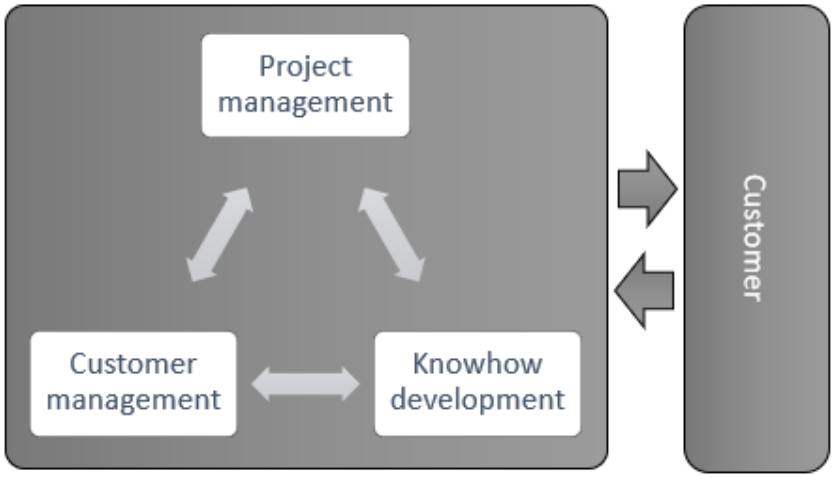

Figure 12. Core processes within case company management system.

4.1 Customer management process

The customer management process (figure 13) aims to cover all necessary activities in the customer interface to ensure that the company and its offering is well known for potential customers and that quotations are received and finally contracted. Activities that are needed prior the contract is signed, are covered under this core process guidance. The process is further divided in to six sub-processes: customer relationship management, sales, offer, order-delivery, customer satisfaction and claims and finally distribution network management. In following sections we will review the guidance starting from last chapters of the sales process, where a RFQ is received until the end of the order-delivery process, where the transition from sales to execution and project kick-off take place.

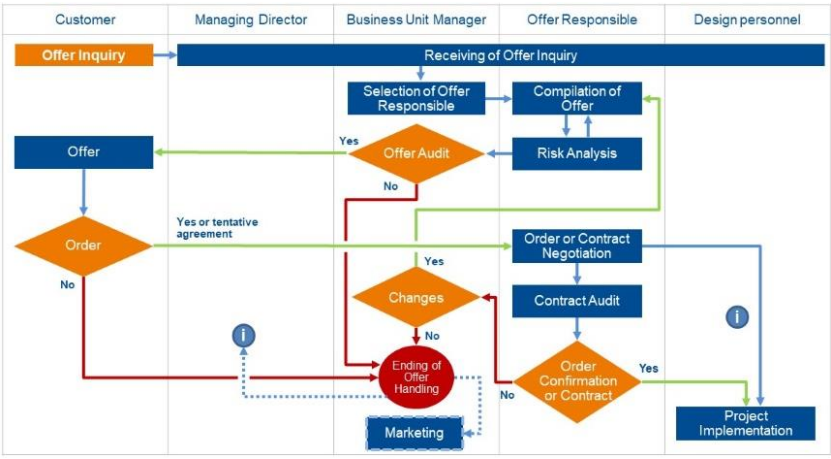

Figure 13. Customer management process.

According to the sales sub-process description, once a RFQ is received, the first step is to carry out a tender review. Within company shared documents there exists a word-format check list template which shall be filled based on review results. Once completed the review document shall be stored together with the related tender documentation. At the same time if any of following conditions are met then an initial risk review needs to be completed as well: new customer and/or novel task that the company has no experience and/or project size exceeds certain percentage of yearly revenue and/or company own delivery scope is less than half of the complete project that is offered. Finally once the tender and risk review are completed the decision to prepare and send an offer or not to the customer is made. If the reviews support the decision to proceed with offering the process continues under the offering sub-process. Otherwise the process ends here.

The offering sub-process provides a detailed description about what should be taken into consideration while preparing the offer, what information should be included, how the information should be presented and most importantly different pricing methods, how the price should be calculated not forgetting about the payment terms. The importance of understanding the customer request and specifications provided as the offer basis is emphasized. The sooner any open questions are discussed and understood the better the estimates and offer descriptions can more likely be provided. Based on case company experiences within consulting and engineering projects more or less 95% of all costs are related to the amount of work hours. To ensure accurate work estimates, knowledge from previous projects should be used as an important source of data for new offer calculations. Sub-contractors can be used to increase know-how and/or impact the cost level to a more attractive level for the customer. In addition to the costs caused by actual designing work, other costs within ship design projects are usually caused by travelling and accommodation related activities. Also the fees for design software licenses, need to be taken into account.

The way the project offer price is determined and what pricing method is offered for execution, sets the financial boundaries for project execution. Within the consulting and engineering environment, three pricing methods are noted to be commonly used:

- Hourly-based pricing: the work is invoiced based on actual consumed design hours, the hour rate can be agreed as same for all hours or then there can be different hour rates for different type of work activities for example.
- Fixed price: a lump sum offer is prepared which includes all activities as specified in the offer. Any work not included in the offer specification shall be invoiced separately.
- Target price: a target price, or target hour amount, is determined in the offer. If the target amount is exceeded then there is a pre-determined factor which is used to calculate the invoiceable, lowered, value of the exceeding hours. In return there is also a factor for possible unused hours if the work is completed with less hours than estimated. For example the factors can be 70% for exceeding hours and 30% for unused hours.

Before sending the offer out to the customer a final offer review should be arranged and documented. Finally when the reviews are completed and necessary approvals are handled, the offer is ready to be sent to the customer. All related documentation, e.g. price calculations, descriptions, internal review memos etc. should be saved to a common location where all offers for specific business unit are stored. After the offer is sent the process continues under order-delivery sub-process which is the final step, if the deal is closed, before moving to the project management process. The order-delivery process provides general guidance how to handle contract negotiations and what needs to be taken into account in the actual contract prior final confirmations are sent out. A contract audit should be carried out to ensure any potential risks are evaluated and there is a mitigation plan in place once the project execution is initiated.

To summarize it can be said that the customer management process provide a common guidance with some options on the way depending on the sales case. Considering ship design project sales, there is no specific guidance. For example the way how the offer calculations in ship design projects are actually prepared and what information is used to back those up will be something to find out based on the interviews.

4.2 Project management process

The project management process describes how the execution of customer and internal development projects should be handled. The guidance is described to aim to ensure all projects are executed with feasible financial performance and sufficient quality. There can be many different type of projects within different industries and the guidance does not provide any industry specific details but rather introduces the general project management procedures which are expected to be common in every project. Within the IMS the most common customer projects are categorized by project type in the following way:

- Design projects
- Engineering, procurement, and construction management (EPCM) projects
- Engineering, procurement, and construction (EPC) / Turnkey (TK) projects
- Research and development (R&D) type of product development projects

Further categorization is done based on the size of the project. Within the case company the project size is usually determined based on the amount of budgeted engineering hours needed to complete the project. There are three different size categories defined:

- Category A – Large projects, estimated hour consumption more than 2000 hours.
- Category B – Medium-sized projects, estimated hour consumption 500-2000 hours.
- Category C – Small projects, estimated hour consumption less than 500 hours.

To determine responsibilities between different project categories there is also a document with listed roles and categories together with main activities. Part of the document is shown in figure 14. Based on this responsibility table, it can be reviews what is expected from different internal stakeholders in different categories.

	Responsibility				Project type		
	Offer responsible	Supervisor	Project manager	Quality manager	Categories		
					C	B	A
General							
Written order/ order confirmation + offer - transfer of order information to the project	x						
Project opening into Lean			x		x	x	x
Project division			x		o	x	x
Billing information for invoicing clerk	x		x		x	x	x
Opening information of EloPro follow-up model for controller		x				x	x
Initial phase operations							
Project planning			x		x	x	x
Project planning, separate meeting if needed		x				o	x
Project resourcing		x			x	x	x
Time schedule		x			o	x	x
Project plan			x			o	x
Basic data plan / reporting			x		x	x	x
Implementation phase operations							
Kick-off meeting	o	o	x		o	x	x

x = will be made always
o = will be made if necessary / separately agreed
z = according to the design order / contract

Categories:

A	Large projects	hour estimation	>2000h
B	Medium-sized projects	hour estimation	500 … 2000h
C	Small projects	hour estimation	< 500h

Figure 14. Project categorization.

The project management process starts when the sales teams efforts have paid off and a contract is signed. The process ends when the project scope is delivered and final closure activities are completed and the project is archived (figure 15). The core process is further divided in to three sub-processes: project commencement, project implementation and project closure. From this research point of view most focus is in the design projects and category A-type large projects. The process will be described until the kick-off meeting and further processes are only visualized to have a basis for possible discussion after interviews.

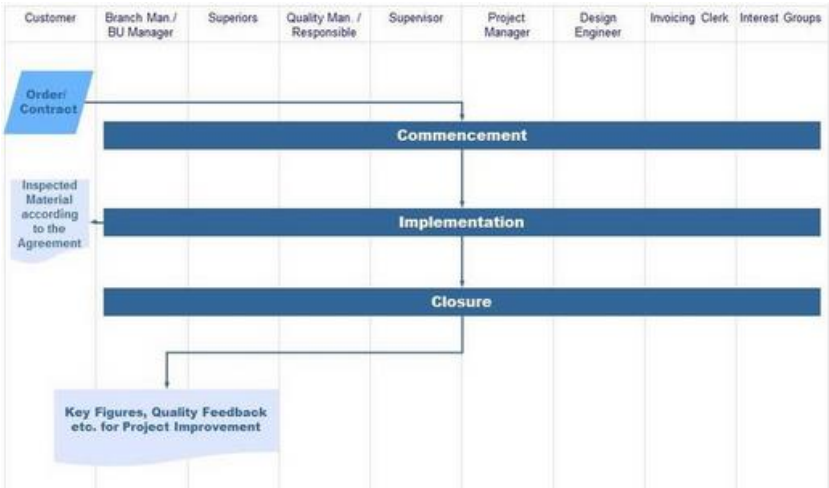

Figure 15. Project execution process.

After the contract is signed and official order is received the project commencement sub-process begins (figure 16). Even though the sales responsible is no longer included in the process chart as one actor, it is described that the sales responsible transfers all requirements and information to the project manager. This is followed by the actual selection of the project manager. The project manager is responsible for the execution and all planning, control and reporting related to it. In addition each project should have a named supervisor. The supervisor's role is to support the project manager and act as a the reviewer and approver of applicable project documentation. Once the project manager and supervisor selection is completed the requirements for the remaining organization are reviewed and persons with required competencies are selected. If seen beneficial, usually for bigger and complex projects, a steering group can be set up for the project as well. It is also mentioned that the sales responsible shall support if any larger contractual deviations are noted at a later stage.

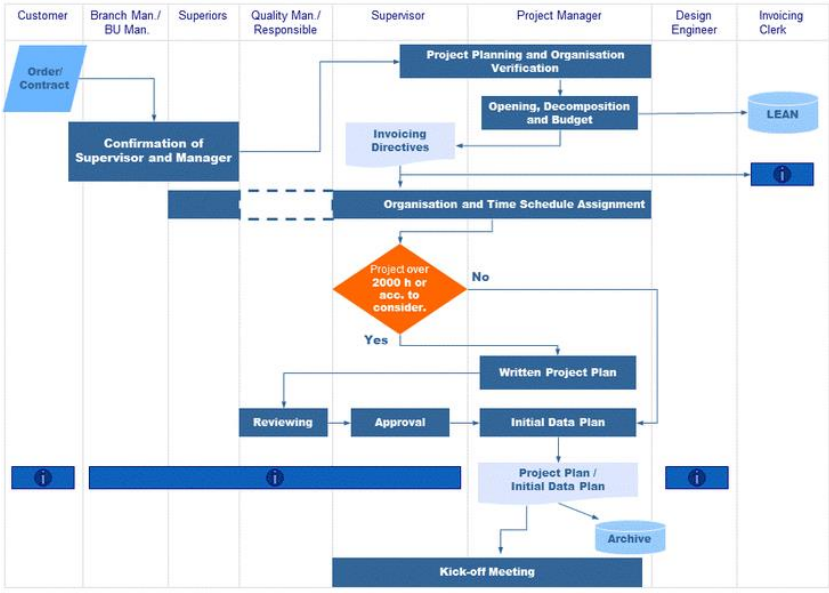

Figure 16. Project commencement process.

Once the key internal stakeholders are in place, the project manager shall start to prepare the project plan. The project plan is a document which should include all necessary information how the project goal will be successfully achieved. The document acts as a guide to all internal project members and it can also be distributed to the customer if separately agreed. There is a common template for the plan and the standard table of contents is shown in figure 17. Depending on project category and possible customer requirements, needed topics shall be taken into account from the contents. The more larger and/or complex project the more detailed the plan and the more attention should be given for reviewal and approval. If done according to requirements, the IMS highlights the project plan as a key document to ensure project success and many of the initial inputs to the project plan are based on the contract.

1.	Description of the project
2.	Scope of work
3.	Schedule
4.	Target or estimation of working hours (cost estimation)
5.	Project hierarchy and organisation
6.	Quality and strategy targets
7.	Information transmittal
8.	Design procedures and instructions
9.	Basic information for design
10.	Guidance
11.	Meetings
12.	Procedures for extra work and changes
13.	Supervising
14.	Reporting
15.	Inspections and approving procedures
16.	Delivery of design documents
17.	Special technical features
18.	Archiving procedures

Figure 17. Project plan table of contents.

Based on calculations in the sales phase the more detailed project is prepared by the project manager. A risk reservation of approximately 10% of the total budget should be taken into account for any unforeseen events. Depending on how the project scope is divided to work activities the budget should be distributed in a similar manner. In the contract phase a document list can be one of the appendices which determines the different documents that need to be delivered to fulfill the scope of work. Therefore one possible solution is to divide the work activities and their budget based on the drawing list. In addition drawings have demand dates which can be used as a baseline for further schedule planning. Following the budgeting guidance there is a short description about risk management. The risk list created during the sales phase should be taken as the basis for further risk management, especially for bigger and complex projects.

In ship design projects the agreed deliverables are many times very dependent on the initial information received from the customer. Understanding and planning when the initial information is required is a key factor to ensure the project schedule remains on track. At the same time it is important to understand how possible delays are handled. This should be

taken into account very carefully already in the contract as it could have major impact on project success if the customer fails to deliver the initial information on time. The project manager should prepare an initial data plan and review it together with designers and the customer. There are different requirements for initial data based on the project categories but basically the projects considered within this thesis are such that the initial data management can be highlighted as one success factor by the IMS. Once the project plan is in place and reviewed by the quality manager and supervisor, next and final step is to arrange the kick-off meeting. The purpose of the kick-off meeting is to familiarize the project team with the project objectives and requirements. The project implementation and project closure sub-processes are visualized in figures 18 and 19. These processes go into details of such matters that are not considered necessary to introduce any further than show the process maps.

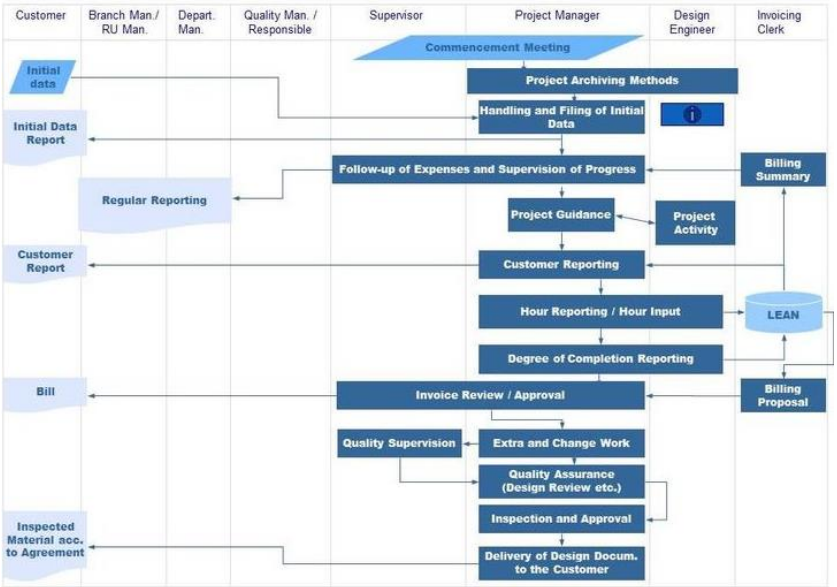

Figure 18. Project implementation process.

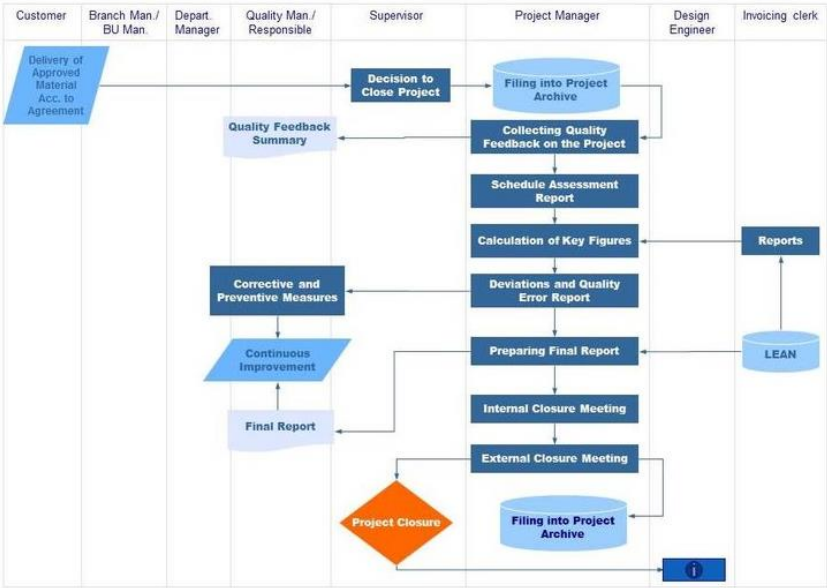

Figure 19. Project closure process.

4.3 Sales and project management software's

To provide short insight about software used within the case company and especially in the sales phase, the company has very recently implemented a new customer relationship management (CRM) tool called Salesforce. Within Salesforce there is a specific sales process (figure 20) which begins when the offer is received and ends when the deal is lost or won. If used at its full potential it is possible to store all the sales phase communication, like emails and phone calls in the system in a rather systematic manner. However the related documentation, like RFQ documentation is not stored within salesforce but to a common network drive.

Figure 20. CRM sales process stages.

Recently the company has initiated some pilot projects to evaluate if a document management tool called M-files, would be a suitable solution to store and handle all documentation. Similar as Salesforce M-files provides up-to-date features to handle the increasing amount of data and not only the files but the metadata linked to those files. If the product is found feasible, it would also mean that the sales documentation would be moved there.

All personnel hours, invoices, and other financial matters handling are taken care of in a ERP system called Lean. Once a project contract is sealed, one of the first actions is to open a project in Lean, to create sufficient basis for project hour reporting and follow-up. Lean is also constantly developed to be able to enable better monitoring of project hour consumption. Synced with Lean, there is a reporting tool to gather relevant project data together and represent those as simplified reports. In addition there is a excel template, to gather weekly project statistics in one same file and more easily review how the project progresses with respect to the original plan.

After reviewing the IMS it is clear that not much is emphasized about the sales and execution interface. Rather both sales and execution are considered as their own entities, when the sales representative has reached the contract next step is “Project implementation” and the sales representative is no longer indicated as an actor in the project execution process maps. It remains to be investigated based on the interviews how the sales and project managers see the situation. If guidelines are followed, the IMS highlights what common matters would be good to take into account. No specific guidance is provided for ship design projects. The only variable in the process is the size categorization, but considering the usual ship design projects, the size is always the largest category A.

5 RESEARCH METHODS

This chapter introduces the selected research and data gathering methods, aiming to find answers to the research questions. In addition it is important that the audience understands the motivation behind the selected methods (Hirsjärvi & Hurme 2011, p. 189). After reviewing literature about quantitative and qualitative research and considering the possible ways to collect supporting data for analysis it was rather clear that a qualitative approach would be a good fit. Qualitative approach can be considered as a suitable selection when you need to understand a phenomenon in general. The data, which is mainly collected within the actual environment, varies from interviews to text documents and it is not possible to specify that detailed questions with pre-defined answers to get sufficient understanding (Kananen 2014, p. 16). There are two main data sources used in this research:

- Records from interviews with case company employees
- Documentation from selected case projects

For the statistics gathering part a group of similar projects was selected from current and archived projects database and related to the selected projects the relevant persons were selected to be interviewed. There are different type of interview methods depending on for example how much open discussion is preferred. Semi-structured interview method was selected for the main data collection in this research as it allows the possibility for the interviewed persons to provide their observations without so strict boundaries how the discussion should progress. Also depending on the clarity of the answer it is possible to ask for more details (Hirsjärvi, Remes & Sajavaara 2016, p. 205). The principle of the followed research process can be seen in figure 21.

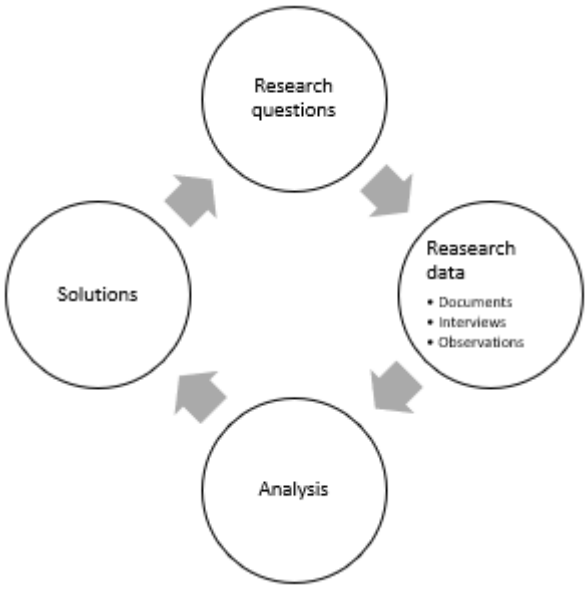

Figure 21. Research process (Kananen 2014, p. 114).

5.1 Gathering statistics from case projects

There is a common network drive where all sales and project related information is stored, separate locations for the sales phase and project execution phase. In addition there is the ERP system which contains hour logs for all projects. Based on initial investigations within these locations and discussions with project and sales managers, similar type of projects were gathered and finally four projects were approved by business unit management to be reviewed for this research. The selected projects are similar by budgeted hours. The scope of work was related to basic and detail design. In addition all projects were contracted as fixed price projects and the customer group was shipyards. So from project business theory point of view all of the projects were delivery projects to a shipyard which was fulfilling the requirements of the investment owner, the ship owner. Business critical, sensitive information will be hidden, this type of information will be presented anonymous. Projects are named from Project A to Project D. What comes to the size of the projects, considering case companies way to categorize them, all projects where category A projects. In this case it can also be noted that the category A minimum hour limit was exceeded considerably as all projects initial budget was well over 10000 hours. The main characteristics of the selected project are summarized in table 1. In projects A and D, indicated with "*", the basic design was part of another contract.

Table 1. Case projects.

Project name	Project A	Project B	Project C	Project D
Design phases included in contract	Detail design*	Basic and detail design	Basic and detail design	Detail design*
Pricing type	Fixed price	Fixed price	Fixed price	Fixed price
Size category	A	A	A	A

The information available in the common folders was one topic for further discussion in the interviews and at the same time valuable interview time could be saved to more relevant topics as the interviewer was already somewhat familiarized to the basic information. Further insight to findings will be presented in the results chapter.

5.2 Conducting semi-structured interviews

How much is enough, is a common question when considering how may persons should be interviewed to get a good overview of the phenomenon in question (Hirsjärvi & Hurme 2011, p. 58). When selecting persons to be interviewed for qualitative research the aim should be to find such persons that are expected to have extensive understanding about the phenomenon (Kananen 2014, p. 97). In this case persons with knowledge about project sales and execution and the interface was preferred. Therefore, the sales and project managers of the selected case projects were selected for interviews. The sales manager is always supported by design managers, who take care of the technical evaluation and hour calculations, and therefore the involved design managers were also selected. In addition the general manager together with the financial manager were expected to have an understanding of the matter from a slightly different angle so they were also added to the group. Actual names of the interviewed persons will be kept anonymous and the identification is based on the job title, as visualized in table 2. Labeled with "*" indicates that the persons were not directly involved in any project but reviewing sales and execution from a higher level. Labelled with "**" indicates that Project manager 3 is the author of this thesis, who was not interviewed and the comments if used about the execution of project will be highlighted separately as own observations.

Table 2. Selected interviewees.

Interviewee	Topic(s)
General manager*	Overview
Design manager 1	Sales&Execution
Design manager 2	Sales&Execution
Design manager 3	Sales
Design manager 4	Sales&Execution
Finance manager*	Overview
Project manager 1	Execution
Project manager 2	Execution
Project manager 3**	Execution
Sales manager	Sales

The goal of the interviews was to find out possible issues in execution that could be taken into account during the sales phase. Based on the findings it would be then evaluated what could then be improved during the sales phase. Also especially how the knowledge is transferred to the execution phase was a topic. The structure for the interviews was selected based on the project business theory around the three main project objectives cost, time and scope. In addition from the project management knowledge areas it was evaluated which of those areas could be seen as important additional topics in ship design projects. As there can be a very extensive amount of stakeholders involved within the projects, the stakeholder topic was added to the discussion. Also as the design resources have a critical role in the cost and performance, this was another additional topic. Finally risks and quality management were added as those were highlighted as important topics within the IMS. Under each main topic there was defined specific supporting questions mostly based on the matters noted during the evaluation of the IMS to understand how work is actually done. The structure of interviews is attached as appendix 1.

Due to existing remote work recommendations triggered by the prevailing COVID-19 situation the interviews were arranged as Microsoft Teams conference calls which were recorded. All planned interviews were completed within a two week time frame during spring 2021, ranging from 1 to 3 hour sessions depending on the amount to projects (table 3). The one-on-one interviews began with a common part where the research topic and the goal was introduced. Then the interviewed persons were asked to introduce themselves, their work history in the company and finally open discussion that did they have any earlier

experiences had something been done or considered around the research topic, in the sales and execution interface. Each project was then discussed based on the structure of appendix 1. However it turned out that rather than going topic by topic, in most cases the projects were discussed phase by phase in chronological order and taking into account all the relevant topics in each stage. So the initially defined interview structure ended up more as an checklist to confirm that all topics were taken into account.

Table 3. Interviewees experience and interview duration.

Interviewee	Years at company	Interview length
General manager*	3	1:17
Design manager 1	20+	1:24
Design manager 2	20+	0:57
Design manager 3	5	1:03
Design manager 4	2	0:57
Finance manager*	15	1:38
Project manager 1	20+	1:15
Project manager 2	5	1:27
Sales manager	20+	2:30

5.3 Data preparation

After the interview sessions the recordings were transcribed within the following week. Language used in interviews was Finnish and transcripts were initially written in same language and later on translated to English during the coding. Transcripts were not written down exactly word by word, but rather the main observations and phrases were gathered. Comments clearly out of topic were not considered. Totally approx. 800 rows out of a total of 12,5 hours of recordings were collected for further analysis. During the next step the transcripts were analyzed to group the notes so that further analysis would be more systematic. This was done by coding the rows within a excel spreadsheet as shown in figure 22.

Note	Topic	Interviewee	Level 1	Level 2
Asiakkailla on yleensä hyvä / realaistinen käsitys töiden tuntimääristä	General	Sales manager	Cost	Negotiations
Vastaantulo tarpeellista että on tarjouskilpailussa mukana	General	Sales manager	Cost	Negotiations

Figure 22. Data coding.

Level one was defined by the main interview topics, level two was defined based on what situation is related to. Coding is a sufficient way to enable systematic analysis of interview results (Kananen 2014, p. 115). To provide some statistics of interviews in general, based on first level coding, the amount and distribution of answers related to case projects are visualized in figure 23. For example it can be seen that most notes were given for project B (193 notes) and scope related matters were most discussed item in all projects.

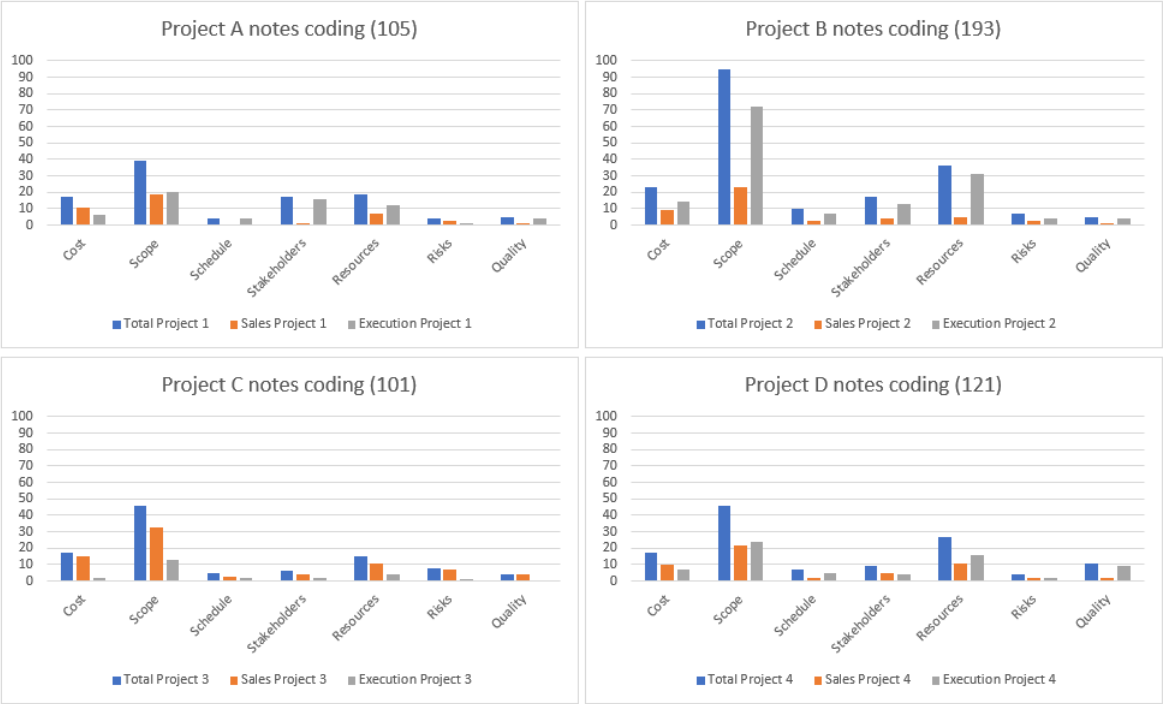

Figure 23. Answers distribution according to first level coding.

6 RESULTS AND ANALYSIS

This chapter introduces the notes from interviews and case project documentation review conducted during spring 2021. To highlight any deviations and additional matters compared to IMS process descriptions, one purpose of the interviews was to find out how things are actually done during the sales phase. Therefore the actual sales process is the first topic that will be described. This is followed by descriptions of the answers from interviews related to the case projects. Finally the reviewed project documentation is used to back up the claims made in interviews and provide understanding how for example the contracts were defined. All descriptions are based on the documented notes from interviews, no own opinions are included at this stage, only statements that are based on the interviews.

When asked about knowledge about the IMS, how the processes are followed and any experiences whether there has been any discussion about developing the content etc., most typical answer was that its existence was known and there was seen some good basic guidance. However seldom is the IMS site visited. Apparently there has been some discussions about its development but no further actions have been taken yet. Some commented that the content is outdated and does not suit the actual needs of projects. Everyone agreed that the sales and execution interface is not taken into account in the process guidance and that introducing a way to handle it could be beneficial. The next subchapter will now describe what steps the sales phase actually includes based on interviews.

6.1 Ship design projects sales process

After receiving the RFQ from a customer the sales manager conducts an initial review of the specified scope of work and checks which design disciplines are included. Next, the design managers responsible for the noted disciplines are invited to join the sales process as technical leads. Outside offer calculation activities design managers main job is to manage the resources pool of their discipline which are part of the marine business unit. It is common that the design managers have previously been project managers and have knowledge about project execution. The sales manager is in charge of leading the discussion with the customer and all commercial aspects.

Offer hour calculation is based on actual hour spend statistics gathered from earlier projects. In addition to hours the cost for the necessary design software's license costs are calculated on top if required. The way the statistics are used depends on the discipline and is usually based on the information available in the GA of the vessel and its estimated main dimension like weight. The GA is a common document in the sales phase and therefore seen a good reference for calculations. For example the dimensions of similar technical spaces like machinery spaces are measured from the GA. Then a hours per square meter (h/m2) or hours per cubic meter (h/m3) coefficient based on earlier projects with similar type of spaces is used to estimate the design hours.

For hull design hour estimations the total steel weight is used as the refence dimension and hours per ton (h/ton) is the coefficient. Total steel weight is a critical number in naval architecture and therefore very precise estimates are available soon after the basic characteristics have been agreed. The weight can be further divided according to the ship building sections or sub-sections if sufficient details are provided by the customer. The more detailed division the more accurate design hour estimations can be calculated. More complex hull shape and structure means greater coefficient. Other disciplines like electrical and interior use similar type of methods. If the amount of drawings is known the calculation can also be based on hours per drawing (h/drw) coefficient, different drawing types with different coefficient values, based on complexity.

One emphasized issue described with the used calculation methods was that if the work methods and the design performance vary considerably then the accuracy reduces. For example different design tools can have this type of impact. From resource point of view the performance is quite hard to know in advance and it is seldom that the perfect resources are available for each projects. Resource selection is finally a matter of compromise. Even though the statistics is an important input to hour calculation it was mentioned that there is not a common statistics database, rather everyone gathers and maintain their own statistics database.

There are clear profit targets to be able to ensure a sustainable business environment. At the same time the price pressure during offering phase trend is increasing. Fixed price contracts are pushed from customers side even though the scope might not be clear enough. The

additional risk due to uncertainty raises the price. Customers have a good visibility on the price level and design suppliers using low cost resources don't make it easy for the ones having a more valuable resource cost structure. Bargaining is a necessity to keep your head above water, and it's a constant evaluation how far down you can go. "Selling is easy if you agree to everything the buyer is requesting". If the price level is indicated as a critical factor to reach a contract, which it many times is, then one solution to reduce the cost is to use resources from lower cost countries.

The case company has an own foreign office with lower cost level and if that is not enough then a pool of pre-selected subcontractors are contacted. How much local and how much other resources shall be used depends mostly on the initial offer negotiations. It was also described that sometimes maybe too much effort is used to minimize and investigate potential issues especially with new customers. Offers content and specification are adjusted sometimes considerably, so that the specification might not fulfill exactly what is requested and therefore the price might not be comparable to other competitors. Finally it was noted, that due to the fact that there is not a common way to document and handover the information about hour and price calculations it seems that the way the final offer is calculated is not always fully understood when project execution takes over. There would be room for improvement how this is handled. The calculation process is summarized in figure 24.

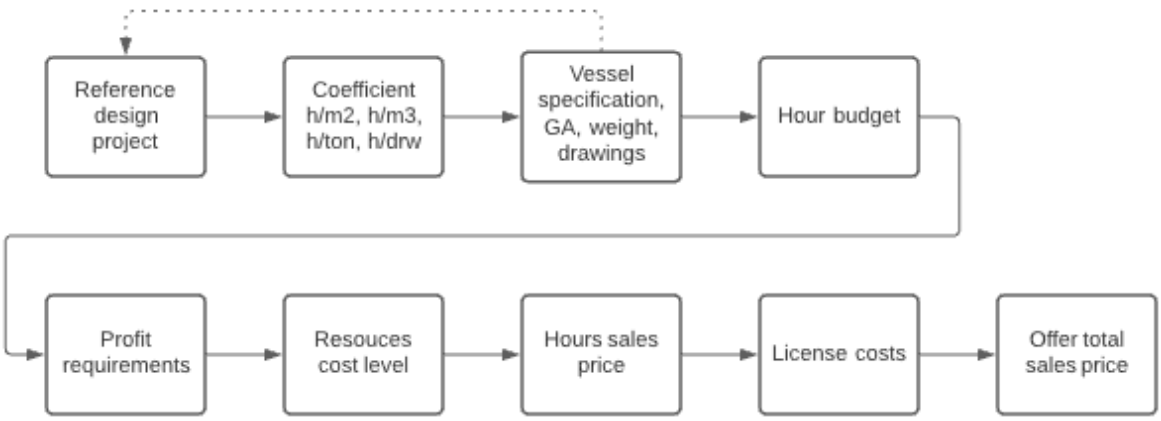

Figure 24. Calculation process.

During the negotiations, how the sales team evaluates the scope of work based on information received from the customer, is described as understood in the offer specification. What is included and what is not, what are the work prerequisites like requirements for any

initial information from the customer. The sales process can take anything from couple days to several months and especially in the lengthy cases, several offer revision rounds are many times needed while the amount of new information increases. If a deal is reached the scope of work is described within the contract documentation package which is reviewed by the sales team before final signatures are applied. While describing the length of the negotiations it was also noted that there are cases when everything seems to be clear but yet the final decision to close the deal is delayed. Even though the preliminary schedule would require immediate actions to ensure sufficient preparation for execution, this matter is neglected and eventually when the deal is closed, there is a need to rush forward. If the prerequisites are not as agreed, the situation gets worse.

Together with the scope specification also the used design tools are described. Whenever 3D modelling is the main scope of work, like detail design, it has been noted that the customer requirements what should be modelled have developed during the years. The required detail level is increasing. The importance of taking the modelling detail level into account in the sales phase is seen as a critical matter. It was mentioned that the latest offers have included more specific information how the scope of modelling is considered. The requirements for diagrams or production assembly drawings created from the 3D model are usually rather similar between projects from content point of view.

The approval process for the drawings or other deliverables is also specified in the contract if possible. For any drawing deliveries there is stated, if possible, a so called freezing period, usually two weeks, to have sufficient time to complete design without including any further modifications to the initial information. Basically this means it’s not obligatory to consider any additions during the freezing period and the new additions can be included in later revisions with additional charge from the customer. In case of any changes to the scope of work occur during execution it is usually agreed so that the change issues shall be mutually discussed and agreed how to handle them. A specific hour rate for any change work is specified in the contract.

Based on answers the common message was that there is usually not seen an issue in understanding the customer requirements and the offer is specified as well as possible. However it is not guaranteed that all the descriptions within the offer specifications are

written in the final contract and this should be somehow improved. At the same time it was mentioned that seldom will every detail be specified within contract and whatever is not specified doesn't mean that the execution could not require more from the customer or should automatically do things that are not described in official documents. It is more up to the execution that the contract is actually followed and that company interest is top priority.

Based on the possible schedule provided with the RFQ, initial estimates for resourcing are evaluated by the design managers. This is usually at a very general level mainly to make sure that there are sufficient amount of resources available and also to evaluate if its required to use subcontractors to manage the work load. Depending on the situation if the project manager is involved in the sales phase then it's more probable that more detailed planning is done during the sales phase. At the same time it's a matter of evaluation how much resources is reasonable to use for different tasks in the sales phase so that time is not wasted. The accurate delivery dates for the deliverables can be available in the sales negotiations but usually the final delivery plan is agreed with the customer upon start of project execution.

Stakeholder, risk and quality aspects were discussed very briefly. An high level overview of the stakeholders can be evaluated based on the customer and project, but any specific persons expected to be involved during the execution is not discussed during the sales phase. Even though within the IMS there was several occasions where risk management is mentioned, seldom is a systematic risk review conducted during the sales phase. It was not described as a major issue, thus it was noted as something that could be improved in the future. The quality requirements are evaluated mostly based on earlier projects and remains a task for the execution to agree with the customer if there is anything specific to consider.

Finally once the post-contract phase activities were discussed there was not raised any typical way to handle the knowledge transfer. The interviews did not highlight other issues than the fact that knowledge about price calculation might not be fully understood. The way the knowledge is transferred is also based on the sales team is organized. If the project manager has been involved then it has been assumed that most information is already understood and the execution might have started without any further handover meetings. A structured handover meeting is not arranged for all projects and all of the interviewees agreed that this would be a valuable addition. The communication between sales and execution was

described to be very modest after the contract has been received. One point that was raised by two interviewees was the way that the company organization was setup earlier compared to the current matrix organization. Previously the organization had been such that the three heads of departments were in charge of sales, projects and engineering all together while now sales is an own entity and projects and engineering are their own. As one commented "It's like there is a ditch between the departments over which you need to hand the necessary information" meaning that once a project is handed over to the project manager then it's considered the project teams responsibility to figure out how to manage the project rather than claim the sales that the prerequisites are bad.

6.2 Summary of sales process related observations

The noted issues during the sales process are summarized based on the three project main objectives, cost, scope and time. The knowledge transfer process is seen as something that is related to everything and therefore considered as its own entity (table 4). Except knowledge transfer, it can be concluded that the possible issues are described mostly to be caused by lack of information and specific requirements, such issues that the sales team has limited or no possibilities to mitigate. The knowledge transfer process is a topic that will be evaluated more carefully.

Table 4. Summary of described issues related to the sales process in general.

	Topic	*Issues*	*Notes about the cause*
SALES PROCESS	Cost	Statistics not accurate	RFQ not accurate, limited experiences about similar vessels
		Pricing method not in line with RFQ descriptions	Customer requirement
		Profit targets are not adjusted	Internal requirement
		High pricing pressure	Customers price awareness, used low cost resources
	Scope	Contract scope specification lacking details	Unable to include all details to contract
		Design requirements not fully reviewed	Assumed based on experiences rather than new evaluation
	Time	Limited planning done	Limited information about schedule, limited resources
		Delayed agreement of contract	Falling behind schedule before starting
	Knowledge transfer	No knowledge transfer process	No specific reason highlighted during interviews
		Common handover meeting is not arranged	Assumed that details are clear
		Inadequate internal communication	Organization structure, no process
		Hour and price calculation methods not understood	No common way to document and handover calculations
		Lacking information about risks	Risk reviews are not conducted as required

6.3 Case project A

Pre-execution phase

The customer was a shipyard and there was a long history of successful design cooperation in several projects with the case company. The previous design project supplied for the customer couple years earlier, was related to a same type of vessel as now in question. The project had been a success from both parties point of view. When the new project was brought to the table the overall economic situation within ship building wasn't good. Nevertheless mutual understanding was achieved well in advance before the required start of execution. The customer was pending final order confirmation from the ship owner and five months passed before the final contract between the case company and shipyard was signed. There were two revisions made before contract.

The RFQ documentation had included the GA and the work scope specification including a preliminary schedule. There were several work packages indicated to be offered. All packages were offered but only a part of the packages were finally included when the deal was reached. The fixed price contract scope included detail design for two disciplines D1 and D2. Software license costs were included in the price. The calculation was done based on the GA. Coefficients for D1 were based on a similar type of vessel done for the same customer, a project which had been completed within estimated budget. The size was bigger but content was similar. For D2 coefficients there was not very recent statistics nor design experiences. It was not recalled how the coefficients were selected at the end. Competition was tough and there were some doubts about the agreed final amount of total hours how the project could be managed. Thus it was noted that any extra hours would have not been possible to include or otherwise the deal would have been lost. The scope specification and terms of the contract were recalled as well understood and suitable respectively.

The project manager was already involved during the sales phase also in charge of D1 offer calculations. In addition the available design team was considered to have suitable knowledge to succeed in the project. Part of the design team was already involved in the basic design phase and this was considered as additional benefit. The foreign office was also included in the design team and a work package was agreed to be done with a specific amount of hours. No external subcontractors were used. Before execution was initiated there was not recalled any specific meetings between sales and execution to evaluate the contract.

Additional efforts to transfer knowledge were not seen necessary as the project manager and other members of the project team were involved in very early stages.

Issues during execution

Soon after getting started, immediately after the contract had been signed, the working procedures, were noted to be different than before. This was not noted nor taken into account during the sales phase. In addition the way the customer had been internally organized had changed. There had been new employees recently recruited to act as the main contact points, i.e. coordinators, in the supplier-customer interface. The coordinator is the first point of contact, ensuring the customer requirements as defined in the contract are fulfilled. Additionally it was expected that the coordinator would ensure the work prerequisites for suppliers exist and support in solving issues caused by the customer or its other partners. The support and communication had changed radically since previous projects and rather than solving issues together the customer mainly focused on monitoring that drawing deliveries were done on time according to the drawing list. If there was an issue with the initial information which had caused a delay, it was seen as the case companies fault rather than investigating the root cause and solving the actual issue together. There were too many issues with the initial information, which were causing a lot of problems to progress with the design as required.

Further issues were noted with how the hull model was progressing. The hull model is a prerequisite before any further outfitting like piping can be done. A online hull model was available but it kept changing and no one informed about these changes. At the same time the customer was raising quality issues due to the fact that pipes routed according to an earlier hull structure were now colliding with the updated hull structure. It was rather straight forward to indicate the root cause of hull changes. Copies of the main model were saved on a weekly basis and it could be checked what was the situation at time of the pipe routing. The problems caused by hull changes were raised as change work. There were many change work issues raised during the project but the handling was noted to have gone rather smoothly. The way the change work process was defined in the contract was followed.

Considering the different work procedures one major change was that additional items were requested to be modelled. This was not taken into account in the contract. Nothing similar

had been done ever before nor was anything mentioned about this type of model detail level in the sales phase so it came as a surprise. The matter was raised as an change work request but the customer did not agree. All together these issues caused the communication to be quite unpleasant. During approximately half way of execution, when 2/3 of budgeted hours were used, the project manager was changed. At this time it became clear that the remaining hours would not be enough to complete the project. The new project manager had previously been the supervisor of the project so he had some understanding about current situation, however most effort was required to keep the strings together and minimize the budget overshoot while delivering drawings on time. The work related to D1 was completed fairly well. The work related to D2 did not perform as expected and caused the overshoot. After completion the budget was exceeded significantly but the overall schedule was kept with minor delays in drawing deliveries.

6.4 Case project B

Pre-execution phase

The customer was a shipyard. The relationship was new and there were no experiences to execute the requested type of design project together. The basis to start the negotiations was evaluated as usual. Comparing to case project A the general economic situation was much better. From the first customer contact, it took eight months until the contract was signed. The fourth offer revision was the final one.

The RFQ documentation had included the GA, a list of required basic design drawings, ship outline specification and the work scope specification including a preliminary schedule. Similar way as in case project A the first offer was done, as requested, for a larger scope of work but only a part of the scope was included in the deal. It was noted that the contracted scope was significantly smaller compared to the full work scope. The fixed price contract scope included basic and detail design for one discipline. The calculation for the basic design was done by estimating hours for each drawing, and the detail design was approximated based on the amount of basic design drawings using a specific coefficient. Due to the fact that basic design was included the assumption was that the foundation for detail design work would be good. There were suitable reference statistics for calculations from previous projects. It was noted that there was sufficient overall understanding of the work requirements. The prerequisites for accurate calculations where estimated as good.

From customer side there was experienced technical experts involved during the sales phase. As background information it was noted that the case company organization was such that the discipline responsible for execution was not part of the marine business unit. There was a common discipline serving all business units. The discipline manager was involved in the sales phase responsible for calculations. The project manager was selected in advance but not involved in negotiations. Transferring the knowledge to the project manager was taken care by the discipline manager. It was noted there was negligible communication between sales and execution after the contract was signed. The sales manager didn't recall any questions were raised regarding the contract.

Issues during execution

The basic design phase was initiated by the project manager. No particular issues were highlighted and eventually the calculations for basic design turned out to be very accurate and it was completed within budget. Once moving on to the detail design phase, six months after contract, the project team started to encounter problems. First there were noted issues with initial information due to lacking details of actual equipment. Another issue was noted about how a task had been miscalculated during the sales phase. Based on a reference vessel it was estimated that a modelling task would need to be done about 3000 times. Then based on statistics it was estimated that on average the time to complete one task would take about 15 minutes, resulting in 750 hours. The actual amount of required times was triple compared to the initial estimate. This was noted to be caused by more complex systems. Additionally the time to complete one task was exceeded significantly due to design flaws done by other parties which took time to get fixed.

Due to problems with initial data and additional work required to complete the miscalculated tasks the amount of delayed drawings increased steadily. This resulted in poor communication between the project manager and customers coordinator. Eventually the situation reached a point where both sides were mainly arguing and no progress was made. To improve the situation the deputy project manager took over the responsibilities. The deputy project manager, had been involved in discussions from the beginning. At time when the new project manager stepped in approx. 2/3 of hours were used and 1/3 progress was achieved. The new project manager and the coordinator had earlier experiences working together so soon the communication improved to a better state and the situation started to

recover. Even with the new project manager it was noted that the drawing approval process and change work requests were not going as defined in the contract. First of all the customer was delaying drawing approvals so that new modifications to the initial data was claimed as a drawing defect and not approved as change work. Also the contract scope was noted to be imprecisely described and it provided the opportunity for the customer to claim some change work requests belonging to the contract. As noted by the project manager, when deliveries are late and even though the reason for this can be external, you are still in a poor position in negotiations if you need to request any type of compensation.

It was described that there were some, more project management, related issues also noted in the beginning. When there were problems with initial information, planning was inadequate to maintain good pace with deliveries not impacted by the missing information. Rather many of the resources were slightly lost and not aware what would have been good to do in the mean time when other matters were not clear. How the team was organized was noted as another issue. The project manager was physically located in another city while most of the project design team was in other locations. Internal communication was not sufficient. Some of the designers were not completely familiar with the design methods used in ship design were more experienced in land-based design methods and this required support from other colleagues.

Couple notes were made about used design software's. Modelling is one thing and creating drawings another, separate software's for both. In the sales phase it had been agreed that the yard would provide necessary licenses and support for the design software. Either party did not have good experience about using the design software in question and additional hours were consumed to setup the system to work in effective manner. For the detail design drawings there was an initial plan to use a well know software that the designers had good experience how to use. However during the start of the detail design it was agreed internally that a new software should be used. The motivation for the decision was to test the actual design performance of the new tool which had been noted otherwise a better fit for the case company. The new tool required more additional hours to set it up and learn how to use it.

One design manager summarized "Designing detail design drawings is like making pasta, you insert the dough (initial information) to the roller and rotate the crank (design process)

to get the perfect pasta (drawings) out. In this project the rollers were running like crazy, but at times there was no dough". Based on the experiences the initial budget was optimistic even without any major issues. A delayed start with only couple resources would have been a good decision in the beginning to minimize wasted hours. The project exceeded the budget significantly and the deliveries were late until the end.

6.5 Case project C

Pre-execution phase

The project had a similar type of starting point as case project B. The customer relationship was new and there were no experiences in executing the requested type of design project together. The economic situation was even better than before. The case company had short-term order books full. The negotiations didn't take long, approx. two months from RFQ to contract signing. Due to the full order books everyone had many projects to work on, and it was noted that the negotiations phase was quite hectic and that some things needed to be rushed to manage everything. Nevertheless there was space in order books and three offer revision were needed to close the deal.

The RFQ documentation had included the GA, a list of required basic design drawings, a list of reference basic design drawings and the work scope specification including a preliminary schedule. Similar as previous case projects the initially offered scope reduced to a smaller scope in the contract. The fixed price contract scope included basic and detail design for two disciplines. Software license costs were included in the price. The calculation was done based on the GA. One helpful matter during calculation was the fact that the new vessel was supposed to be designed according to a reference vessel with minimum changes. Additionally when the reference vessel was under construction, some years earlier, the case company had been involved in same design tasks related to same disciplines as requested now. There was exceptionally good knowledge about the scope and accurate statistics to calculate the new offer. Negotiations were demanding, and to achieve required profit margins, it was necessary to use resources from the foreign office to cover most of the design tasks. Most of the reference vessels as-built basic design documentation was supposed to be available and the purpose was to use that as a strong basis for the new design. Considering the indicated minimum changes to reference material by the customer, the estimated readiness level of the initial information for required design activities was expected to be

high. Support for part of the basic design was also included in the contract which was estimated to guarantee even better understanding for the detail design to conduct work successfully.

It seemed that the same resources, who were involved during the reference vessel design, would be available for this project. The project manager was not involved during the sales phase and was selected before the start of detail design phase. The detail design modelling work was requested to be done with a new software. There were doubts about how the new software would perform as the internal know-how to use it was modest. Internal training sessions were to be arranged before start of detail design activities. Additional appendices were included to contract to clarify the responsibilities related to modelling and necessary model administration. The final contract and terms were noted as good. Even though possible performance issues with the new software were noted the execution was still expected to go smoothly.

Issues during execution

There was only one resource involved in the basic design phase and a fulltime project manager was not necessary until approaching the start of the detail design, six months after contract. A project manager who had joined the company some months earlier was selected to lead the detail design phase. The contract documentation was reviewed together with the sales manager, who was also selected as the supervisor of the project. The design manager who was involved in offer calculations and had been part time project manager during the basic design was also included in discussions. At the same time the design team was taking part in software training course to mitigate the possible efficiency issue. The startup phase was noted to be a very busy time as many large projects were in progress at the same time.

The initial information seemed sufficient in the beginning but step by step it was noted there was increasing amount of inconsistencies and mistakes emerging. For example depending on where designers looked they could find different specifications for the same matter. The single issues were not major but as the amount of those increased and they were related to critical diagrams it started to slow down the, what should have been straight forward, designing process. Even though minor individual issues, the reaction time on the customer side noted to be very slow and designers were waiting long times for critical information.

The systems with issues were managed by different disciplines and the communication between different disciplines did not seem to work at all. It was also noted that the expected benefit from being involved in the basic design was not realized, most time was spent in solving open issues. The large amount of unsolved issues resulted in delays until it was agreed that these issues could be left out of scope. The open issues were to be added later on when sufficient information was obtained. To catch up the schedule, more resources were added to the design team and the pace started to improve. Still the performance was not optimal as the issues remained in the initial information. The drawing list with expected delivery dates contained 2/3 unnecessary drawings and took some time to reach mutual understanding what was going to be delivered.

Considering the support from the customer, the main coordinators were reorganized couple times during the project. Once the basic working methods were agreed with the first main coordinator the next one introduced additional requirements. A lot of work procedures were agreed with email or meetings and it was difficult for everyone to follow and remember what was requested at which point. Many requirements were learned based on feedback from customer after designing the first version of a drawing. It was seldom that by following the initial information, customer general work instructions and designers own experience, would have been enough to get drawings approved. Comments about drawings were many times based on individual opinions and the rejections caused by this caused additional delays. The support with the modelling software was similar as during case project B. Constant feedback from designers was necessary to improve the modelling environment, and that consumed additional hours. Overall the estimated readiness level of the initial material was not as expected based on the sales negotiations. This caused the hour calculations to be under estimated. Most of issues were solved eventually and the remaining 1/3 of the project went smoothly. However the damage was already done during the early stages and the budget was exceeded significantly.

6.6 Case project D

Pre-execution phase

In the recent years there had been some minor collaboration with this shipyard, also very large projects but further in history. This new project was seen as an opportunity to increase co-operation in larger scope projects. The economic situation was stable. Initial agreement

was achieved in couple months but it took eight months until the final contract was signed. Three offer revisions were done during the negotiations.

The RFQ documentation had included the GA and the work scope specification including a preliminary schedule. The specification was for a specific work package. It was not possible to distribute the package to many parties like in previous case projects. It was noted that the content of the RFQ was described in a very detailed manner. The fixed price contract scope included detail design for one discipline. The calculation was based on the GA. A reference vessel where very similar type of technical areas had been done, was used to define the coefficients. The price negotiations were demanding. The foreign office and an additional subcontractor were required to ensure attractive pricing level with the required margins. On customers side there was noted very experienced technical handlers involved in the negotiations. Together with the sales team design managers they handled most of negotiations while commercial responsible where observing from the background. Technical matters came first and commercial matters followed. Having experience of detail design the customer team had also evaluated the required design hours internally. This way the customer could compare the sales teams calculations with their own estimates and vice versa. The offered work was in the ball park of the customers estimates which raised the confidence that both parties knew what was on the table. Required initial information was carefully reviewed and possible issues discussed together. The preliminary drawing list including the delivery times was available. Additionally developed work procedures were highlighted.

At the time it seemed probable that there could be highly experienced designers available to take part in the project. Contracted earlier, there were already couple designers involved in the basic design with a solid track record working at the yard and good knowledge about the systems in question. The project manager was not involved in the sales phase. All in all it was noted that the achieved conclusion was satisfying to both parties and there was solid foundation to execute a successful project.

Issues during execution

The project manager was engaged well in advance before the start and there was enough time to get familiar with the objectives. A meeting was held between the project and sales

manager to discuss the content of the contract. One issue noted during the startup was the fact that a contract had not been made with the required external subcontractor. The project manager took the lead to make the deal, but as the initially selected subcontractor was aware about the situation and knew that the project manager did not have time to waste the subcontractor had the upper hand in price negotiations. Finally a contract with the subcontractor was signed with higher price than estimated. Besides this there was not further issues noted and the remaining notes are described to highlight possible reasons why things go as planned.

The same technical professionals from the sales phase continued as main coordinators during the execution. A full day kick off meeting with the yard was arranged. The purpose was to review the requirements in a detailed manner: project in big picture, design requirements with several examples, introduction to work procedures etc. All design team leaders from the different locations attended. Everyone had good understanding what was required and what was to be expected from each party. One design area that was not included in the contract was added to scope as extra work. From resource point of view, as estimated, the experienced designers were available to join the project design team. It was described as the dream team. The basic design designers continued their work in the detail design with a smooth transition. The experiences from basic design phase supported the detail design as expected. Also the project manager was modelling when additional support was needed. Where it was seen possible the start of design activities were delayed as long as possible to ensure all possible updates to initial information were available.

During spring 2020 the marine industry was hit by the COVID-19 situation. Due to rescheduling of vessel deliveries to the ship owners, this project was frozen and finally the contract was terminated with an preliminary agreement to complete work later on. While writing this thesis the remaining part still remains to be finalized. Until termination the project performed as planned according to budget and delivery schedule. This concludes the case projects descriptions based on interviews. However as a general note that came up in all projects was that there was no systematic risk reviews done at any phase in any of the projects, and this was indicated as something that would need to be done in the future.

6.7 Summary of case project related observations

Based on the descriptions, the project's success from cost, scope and time point of view is assessed and summarized in table 5. Considering success evaluation based on the notes from interviews, the common message was understood such, that project success is generally considered from short-term, i.e. tactical point of view. The way success is measured is based on how efficiently individual projects perform with respect to cost, scope and time. Cost is directly linked to the calculated amount of hours and is a dimension which is defined in the pre-execution phase. Thus from the three main objectives, accurate cost calculation can be considered the most critical matter to consider in the pre-execution phase. Only during project 4 introduction there was discussion about longer term success objectives, to enable better business opportunities in the future. However despite the fact it was not discussed in other projects it can be expected that all projects aim to be executed in a way that there is a continuity in the customer relationship. The global economic situation is not in such state that any opportunities could be wasted. Therefore, although the initial cost estimate for subcontracting was exceeded during execution, case project D can be considered the most successful project compared to the other case projects. occurring

Table 5. Case projects execution success summary.

	Project A	**Project B**	**Project C**	**Project D**
Topic	*Assessment*	*Assessment*	*Assessment*	*Assessment*
Cost success	Discipline 1 according to budget, Discipline 2 over budget	Over budget	Over budget	In budget
Scope success	Major issues with design prerequisites	Major issues with design prerequisites	Major issues with design prerequisites	No issues
Time success	Deliveries done mostly on time	Delays occurring until completion	Delays during beginning, but schedule was caught up	On time

To gain an overall understanding of the topics and issues described in the interviews, further grouping and categorization was done. First the main notes from the pre-execution phase were gathered together and categorized by topic. It can be said that there was not highlighted any major issues in advance during the pre-execution phase, issues that could cause the projects to fail, as three projects did. In case project A there was described concerns about

the final amount of hours, but nothing was mentioned about following up the matter later on. Risks were briefly discussed in all case projects and raised as an issue that would be good to take into account in the future. There can be different arguments but the fact that the project manager, or other project team members, are not involved in the sales phase should not be considered a reason for project failure. Rather the process should be such that it ensures systematic and common way to gather, document and handover critical information so that anyone joining at any particular time could jump in and gain sufficient understanding. Employees come and go so the less the process is depending on information of individuals the better. Thus the common message about the pre-execution phase was such that it was estimated that there could be good basis for the project to succeed. Appendix 2 summarizes the interview topics related to the case projects pre-execution phase. It can be concluded that there are differences between projects, but for example the initial RFQ documentation and basis for calculations has been similar in each case.

Besides case project D, all the execution phase related interview discussions were around issues and possible reasons why the projects actually failed. In case project D case there was also notes about what went well. The project contract documentation was reviewed to find out whether or not the issues were taken into account during the pre-execution phase. If an issue was taken into account, the following question was that how was it taken into account. The highlighted issues were grouped based on the topics noted in the contract. If there was not a suitable topic a new one was defined. Appendix 3 summarizes the issues, including a description how it was possibly taken into account during the pre-execution phase. There were issues that were considered more related to the actual project management and execution phase related activities, issues that are not considered such that could be mitigated in the pre-execution phase. Table 6 highlights issues that were left out of further analysis.

Table 6. Issues, left out of further analysis, related to execution phase.

Project	*Issues*
Project A	Project manager changed
Project B	Internal organization issues
	Project manager changed
	Inadequate planning in the beginning
	Partly inadequate knowledge about ship design environment
	Internal decision to use a new software
Project C	Busy startup phase
	Supposed benefit from basic design not realized

It can be noted that many of the topics were taken into account in the pre-execution phase, mainly in the form of the project contract, but due to different reasons, the execution was not able to follow, even in some cases, a very clearly described process. The topics within appendix 3 are shortly introduced below:

Budget definition: issues were noted due to inadequate information during sales phase. If the basis for cost calculation is not described in the contract, as it has not been, then it can be problematic to claim the customer afterwards. Could this be taken better into account in the pre-execution phase? It could be evaluated if a contract clause could be included to indicate, at least the assumptions for calculations. Whatever the calculated budget is in the contract, most important is to understand what you are able to do with it, therefore more effort could be taken to descried the way the calculation has been done. If the calculation is accurate and yet the customer requires price reductions which is granted. At the same time if the standard profit margin is required to be achieved, the actual number of hours reduces but the scope remains same (figure 25). If the only information provided to the project manager is the contracted 900 hours and the initial steps are not explained, then for example the planning might end up inadequate.

	Hours	Cost €/h	Cost €	Margin 20%	Offer price
Initial offer, accurate coefficients and cost price	1000	8,00	8 000,00	2 000,00	10 000,00
During negotiation customer requires 1000€ discount					- 1 000,00
Contract	900	8,00	7 200,00	1 800,00	9 000,00

Figure 25. Example of discounting the price.

Design guidance and requirements: in all case projects the customers have had a specific guidance to take into account during design activities. For example in case project A sales phase the situation was such that there was not specific information about the matter, but it was expected to be similar like in earlier projects. This backfired once significant changes were noted in the guidance. Could this be taken better into account in the pre-execution phase? absolutely. Rather than expecting that the process is similar as before it could be verified with the customer.

Collaboration with the customer: issues were mainly related to inadequate customer communication and support and was something that was not expected to be an issue in the sales phase. According to contracts there is stated that the supplier shall nominate a project manager to the project and changing that person requires that strict conditions are met. However nothing was noted that the same would apply to the customer. Could this be taken better into account in the pre-execution phase? When the time from contract to execution is calculated in months rather than weeks it is probable that there is a possibility that the situation in individual stakeholders can change. However the situation could at least be reviewed in advance.

Design prerequisites: problems with initial information can be highlighted as a common issue as it seems to be typical that there is various problems caused by missing, incorrect and changing information. According to contract it’s the customers responsibility to take care of this but based on results seldom there is a perfect situation that designers are able to gather required information and execute without any issues. Could this be taken better into account in the pre-execution phase? The situation can be considered such that would require improved internal communication to ensure that the situation is evaluated carefully before the execution gets to speed.

Approval and change process: issues were covered by the contract but still projects ran in to issues. In the case projects A and B situation it was understood that the processes were neglected by the customer and apparently there was limited possibilities to challenge this. Could this be taken better into account in the pre-execution phase? It is understood that it might not be possible to define these in the contract phase more in detail and thus it is more up to the execution to ensure that the agreed processes are followed. Developing a more

detailed process to ensure that everything within the contract is taken into account could be seen beneficial. Internal understanding about how things should go, can be considered as important as the fact that the customer understands and agrees how things should go.

7 DEVELOPING PRE-EXECUTION PHASE ACTIVITIES

This chapter, proposes solutions how the current state could be improved so that the highlighted issues from results would be considered in advance before they end up realized issues during the project execution phase.

7.1 Issues mitigation with risk management

Based on the literature review what was highlighted during interviews as issues can actually be considered as risks that were realized. Thus risk management could be a suitable way to ensure that future projects don't run into same issues, or if they do, at least it would be taken into account in advance. Risk management refers to activity that aims to 1) identify risks 2) evaluate risks 3) plan and execute to minimize risks likelihood and finally 4) mitigate effects of realized risks (figure 26) (Artto et al. 2011, p. 159).

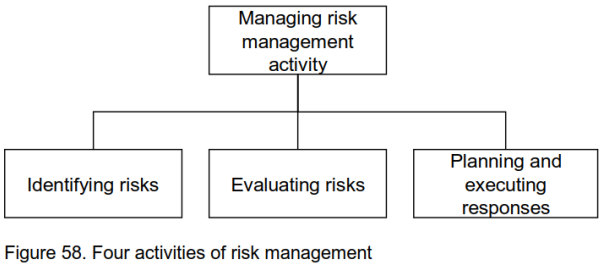

Figure 26. Risk management (Artto et al. 2011, p. 159).

Based on the risk management ideology, the highlighted issues where written in a form that states the probable cause, provides opportunity to assess the situation at different stages and finally provides proposals about actions that would be required to be done if there are doubts that the issue could be realized or there is no understanding about the issue. The issues are presented in a risk management type of form in appendix 4 and figure 27 represents one way to evaluate the probability and effect of risks. Using this form during the pre-execution phase, could be seen a suitable way to keep the most critical issues under control. Each risk would be evaluated and further follow-up would be agreed. Based on new experiences from completed project the list could be reviewed and updated. For example the effect evaluation

for each risk could be based on earlier experiences rather than evaluation it each time separately.

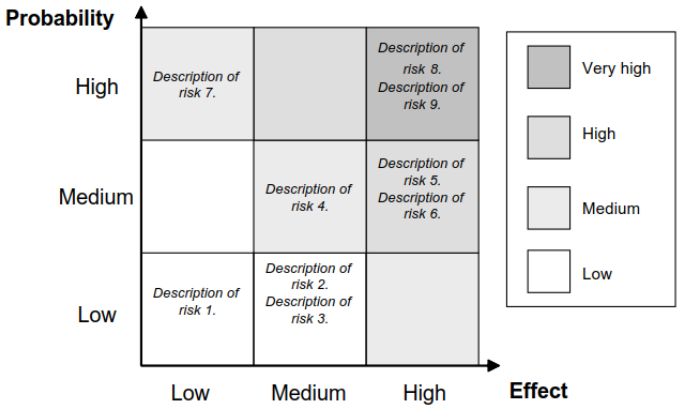

Figure 27. Risks probability and effect evaluation (Artto et al. 2011, p. 170).

To mitigate the issues already during the pre-execution phase, the most relevant way to do it would be to get them specified within the final contract. In the interviews it was noted that amending the contract is easier said than done, thus should be something that is always systematically reviewed. Considering the inadequate reference for calculations, one way to mitigate that within the contract would be simply to have a description of the used reference and how it has been taken into account. While reviewing the case project contracts in some cases there was a short clause about the matter: “The supplier understands the scope of work and requirements.”. Basically the clause could continue with the description how it is actually understood: “Vessel X is used as the main reference…”. What comes to the subcontractor and other partner agreements, it should be ensured that anything impacting the cost level should be preliminary agreed in such manner that the cost level cannot be changed unless the initial scope changes significantly.

Similar way as every customer has usually a “General terms and conditions” (GTC) -document attached to the contract the case company could create a “Case company best practices for design” (BPD) -document which would cover different design project types and have descriptions of common ways how the design process is excepted to progress. For example there could be a description about the how the communication and support with customer is expected to go. Including this document with offers and requiring it to be included as an contract appendix would immediately highlight the possible weaknesses in

the contract if the customer would not be ready to approve parts of the BPD or totally reject it. The basis for the document could be the list of issues in appendix 4.

7.2 Improving the sales process in CRM

To ensure that the highlighted topics would be systematically taken in to account in future project opportunities, the question is that what could be the best way to do it? As it seems that the IMS guidance is not accessed on a daily basis, only adding new guidance there is not seen as the best option. Attention is focused to the software's that are used during the sales. Therefore Salesforce CRM would seem like an efficient way to first of all gather all the data during the sales phase and finally ensure that the knowledge is transferred to the execution phase. At the high level the sales process should end when the handover to execution is complete. Looking at the current process this could be added as a step to the current process map.

Currently the process within salesforce ends when the deal is won or lost. Before this there is an earlier stage "Closing" which includes information about "Goals for Closing stage" and "Tasks in Closing stage" (figure 28) that should be completed before finally closing the sales phase. As understood from interviews usually there is a point when both parties officially agree that the contract will be done, meaning that the deal can be considered won. This is followed by the fine tuning of the contract and final signatures, and then the contract is handed over to the execution.

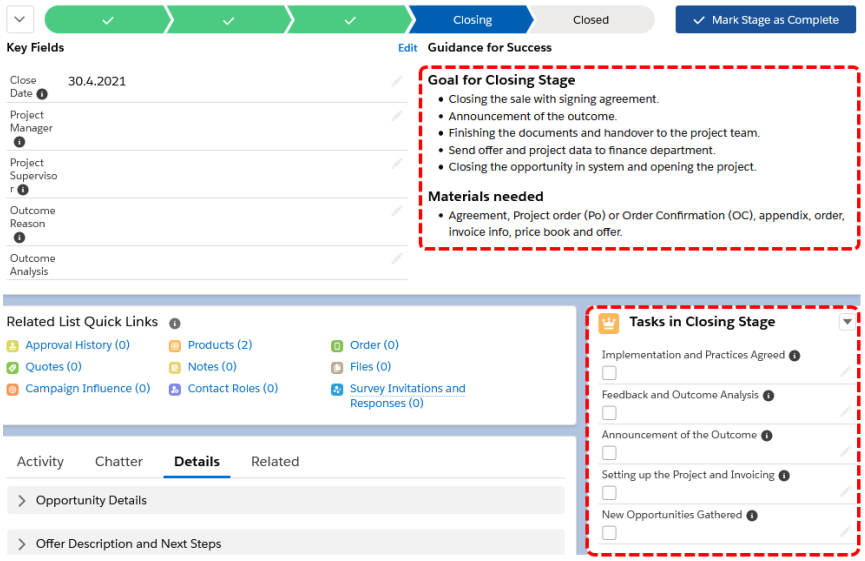

Figure 28. Process guidance in CRM.

The current CRM sales process does not seem to fully align with this, due to the fact that the process is not closed as won until the contract is signed. The process remains open until the final step. At the same time the guidance requires tasks, similar as highlighted by results, to be done prior final the step. This might lead to situations that the tasks don't get the needed attention the stage is skipped to get deal closed in the CRM. The claim is based on the assumption that to ensure sufficient information for sales reporting the CRM stages are kept up to date and thus the sales might report, especially the won, cases as closed to get the reporting up to date, rather than keeping cases in closing stage to ensure the handover is done. Based on the findings from interviews, when the contract is finally agreed with the customer, it would be necessary to have a clear phase that engages the parties from sales and project execution to review the basis for projects. Therefore a new stage called "Handover" would be included as a stage in the current process and it should follow after the current closed stage (figure 29).

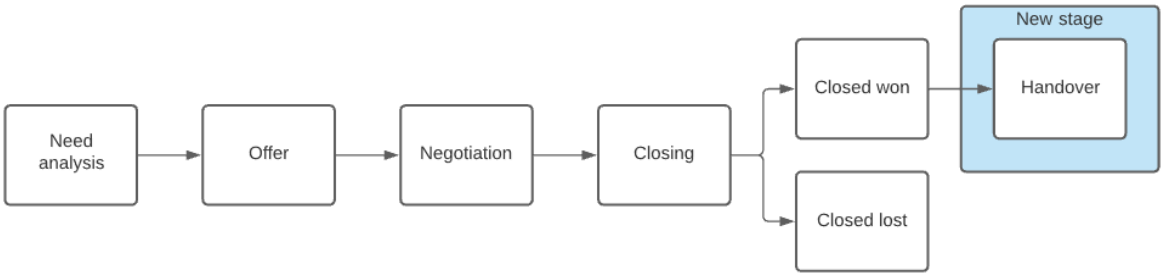

Figure 29. New CRM sales process.

The tasks initially described in the closing stage, related to project handover activities, would be moved under the handover stage. The new goals for the closing phase would be to ensure that the potential issues arising from issues described in appendix 4 "Review during pre-execution" are taken into account and that there is mutual and documented understanding with the customer about critical points. This could be added as a task list or a link to the closing stage and it would be filled and reviewed with the best understanding available at that time. The point is not that there should be answers for everything but rather highlight which matters have not been possible to take into account. Once moving forward to next stage the system could highlight the need to arrange a handover meeting and possibly even do the initial invitation based on the settings and role definitions. (CMSwire 2018.) The preliminary agenda for the actual handover stage could be as presented in table 7. Appendix

4 would be the supporting document which would be reviewed during the handover stage and actions would be agreed how to react if the realization seems probable. Finally it is good to note that it is possible that none of the stated issues will be realized or any way valid during a project.

Table 7. Agenda for handover stage.

Topic	To be reviewed
Offering phase walkthrough	Initial scope definition
	Used references
	Used calculation methods
	Profit expectation
	Contract type
	Competition
	Needed resources
	Impact of revisions
Budget evaluation	Contracted budget and what are necessary actions to ensure it can be reached
Scope definition and complexity evaluation	Contracted scope and what the prerequisites are expected to be
Schedule evaluation	Schedule and how tight or flexible it seems
Customer collaboration	Customer collaboration expectations
Internal resources	Resources availability and competence
External resources	Contracting status
Internal communication	Agree how communication with sales and execution will be handled during the project
Key risk review	Appendix 4 as base line, to be amended if needed. Further actions according to the results

The CRM could also be the place to ensure that the price calculation is logged in a common way. The system is configured so that the total sales prices is a sum of the listed products total price (figure 30). Products are selected based on discipline and the type of activity like basic or detail design e.g. “Interior DD”. Currently it seems that the total sales price is the only factor which is possible to be tracked, but it could be possible to add more mandatory fields in the system to provide better visibility how the product prices have been changing. For example the opportunity product page (figure 31) could have fields like “Calculation excel”, “Calculation reference” and “Calculation coefficient” included. Additionally as it seems that there is no possibility to track changes in opportunity product page, there could be a text field to keep a change log.

	Product	Quantity	Sales Price	Total Price	Line Description
1	Cabins & Interior				Interior DD
2	Electrical				Electrical dd
3	HVAC				Hvac dd

Figure 30. Products list of an offer.

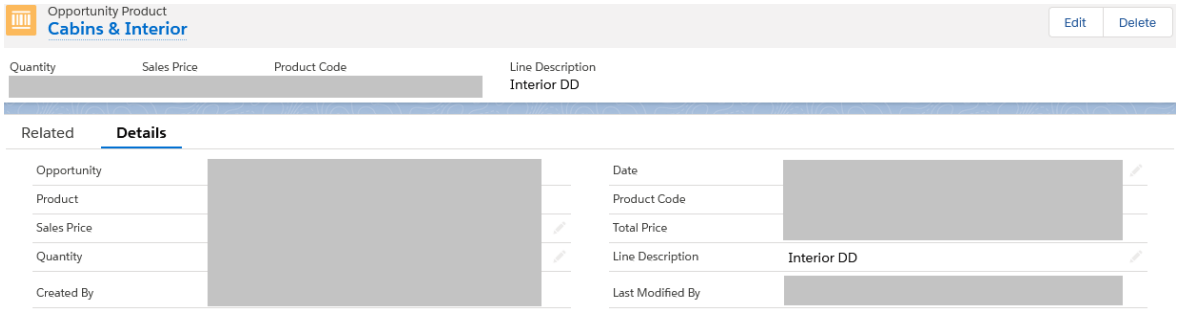

Figure 31. Opportunity product page.

7.3 Diamond model for project evaluation and categorization

It could be good to have a way to evaluate the design projects in a common way. The evaluation would be done during the sales phase and again when execution is starting up. Additionally a more systematic analysis is supported by the fact that many times the time period from the initial RFQ until contract and finally to the project start can be anything from weeks to several months. Thus in case the execution is far away it can be argued that what is reasonable to expect in the contract. If the prerequisites are not as expected during the sales phase the sooner it is noted the better. Shenhar & Dvir (2007, p. 13) have introduced a so-called diamond model to evaluate projects, not only to select the correct project management approach but also to review different situations in a similar manner to finally find the uniqueness of each project (figure 32).

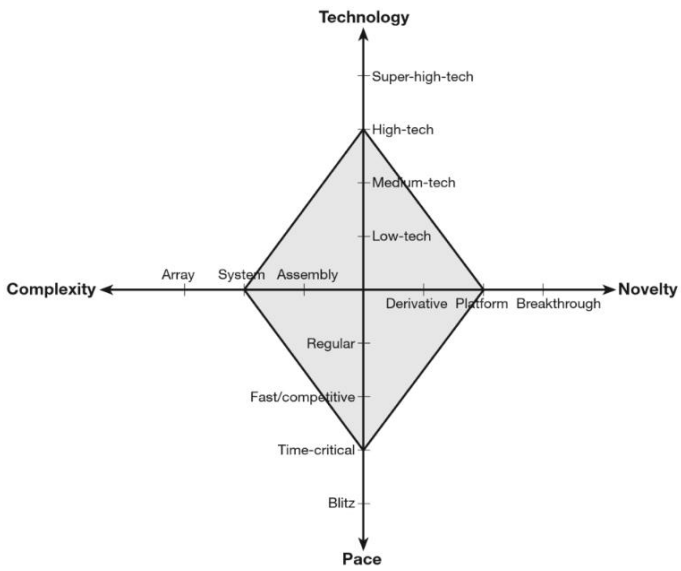

Figure 32. Diamond model (Shenhar & Dvir 2007, p. 14).

Its objective is to provide a common language between all internal and external stakeholders (Shenhar & Dvir 2007, p. 13). By defining ship design projects specific criteria, this type of model could be seen one way to improve project evaluation and comparison in different phases. It could also provide a new way to categorize different projects and then actions could be aligned according to different type of diamond models. One way to define the structure for the diamond, taking matters relevant for ship design projects in to account is visualized in figure 33. The grading from 1-5 would provide understanding about how critical each topic is assessed to be, and the specification for grades could be defined in advance.

Topic	*Grade*	*Assessment 1 → 5*
Contract definition	1	Well defined →
Reference projects	1	Good reference →
Complexity	1	Good competence →
Offer competition	1	No competition →
Customer relationship	1	Existing relationship →
Amount of disciplines	1	One →
Project size	1	1000h →

Figure 33. Diamond model for ship design pre-execution phase evaluation.

7.4 Stakeholder matrix for customer evaluation

Olander & Landin (2005, p. 322) have introduced, a stakeholder management matrix, a way to evaluate different stakeholders based on their interest and power to influence (figure 34). By using this matrix, the required actions like communication should be aligned accordingly. It would be recommended that this type of analysis would be done latest during the handover stage. At the same time the stakeholder matrices, if available, from previous projects preferably execution phase could be considered. In this way the sales could take needed actions and finally a re-evaluation of the situation could be done based on project managers experiences. Similar way as the diamond model the point would be to have a common language and ability to have a simple way to compare situations at different stages.

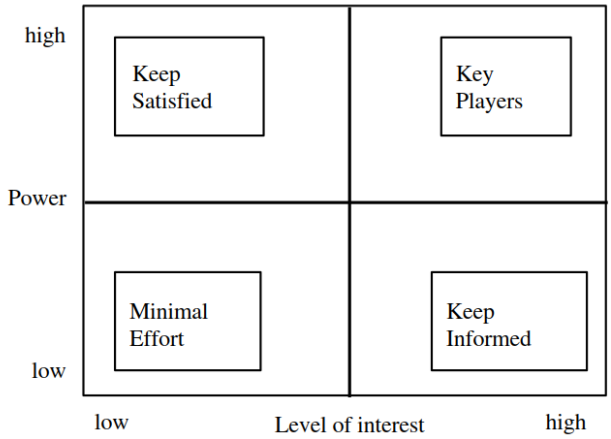

Figure 34. Stakeholder management matrix (Olander & Landin 2005, p. 322).

To conclude the chapter, it can be said that the most critical improvement would be to tune the pre-execution process to such state that it would ensure that the information flows in a suitable manner to relevant stakeholders. The other proposals are seen valuable additions to support the process and by testing these methods in action it could be further evaluated how they do actually support or would there be a better way to ensure a common language in all projects.

8 DISCUSSION

This chapter summarizes the whole research process and answers the question how the initially set research questions were finally answered. At the same time aspects that are common in scientific research are discussed.

8.1 Comparision with existing research results

Comparing the results to the literature, probably one main finding was the fact that the sales and execution phases are treated as own entities. The IMS and findings from literature are very much aligned what comes to requirements during project lifecycle. The interface between sales and execution is something that is not taken into account. Overall limited amount of literature and research was found around the topic of how the issues in execution could be taken into account in the pre-execution phase. As one topic previous research have raised the importance of having the project manager involved during the sales phase as something that could be considered beneficial. Based on the results seldom this is the case and it is something that can vary depending on the current situation. Sometimes there might be the project manager available immediately after the RFQ is received, sometimes the project manager is not even recruited before closer to the start of project.

Therefore at least in the case company case it is not seen as a feasible solution to take significant actions to ensure that the project manager would be involved, rather the importance of a systematic information collection and transfer process should be enabled to ensure all parties, joining at whatever phase have the opportunity to gain needed knowledge. Besides the project manager topic it is not really possible to do any further comparison, rather the literature review provided detailed insight about the ship design project environment to ensure basis for successful interviews ie. where to focus the attention and finally after interviews, look for possible solutions to the noted issues.

8.2 Objectivity, validity and reliability

Validity and reliability are used to measure trustworthiness and the quality level of the research and the used methods. In a qualitative research the researcher has a major role when these factors are analyzed. Thus it is quite impossible to determine a qualitative research

fully reliable and valid (Kananen 2014, p. 146-147). To be considered reliable the researcher should be able to accurately define the research process and the used methods so that a fellow researcher is able to repeat and gain similar results. Validity takes into account if the selected research methods are able to provide required and accurate enough results for the defined research problem. (Creswell 2014, p. 201.)

Triangulation is one way to try to prove better validity. It means that different sources of information are used to understand the noted issues (Creswell 2014, p. 201). It can be said that triangulation was taken into account in this research as there was used different type of sources for information. In addition interviewing different persons about the same topics could be considered as a form of triangulation. The same sales manager was involved in all projects so that's only weak point when discussing the initial sales phases. However one or ten sources still does not guarantee that the sources provide accurate information about the issue. Documents might be written in an objective manner and answers for interviews might be given in similar way. Another common way to increase validity, which was used in this research, was to send the analysis of the interviews for review to the interviewed persons. Based on feedback, besides comments on typing errors, the interviews were understood and described in the correct way. Of course the more time there is between the interviews and results the more likely it is that the persons don't remember exactly what they have said during the interviews. In this case there was approx. 2 months gap. Possible biases are also important to introduce (Creswell 2014, p. 202). As the author is one of the project managers it is critical that an objective mindset has been kept and own opinions were not introduced during the interviews and transcription process. However it still is possible that there is bias as it might occur even through the questions, how they are defined.

What comes to the reliability aspect of this research, the probability that even the same researcher would be able to get exactly same results is estimated to be small. Even if the process and methods would be explained in the most detailed manner, there is still too many variables to end up with same answers. For example as a researcher with a rather modest experience about doing research, conducting a project like this is a constant learning process and experiences and feedback would most likely impact the set up if done again. Therefore if another researcher would try to replicate the data gathering process it is unlikely that the results would be exact same but the overall problems could still be expected to occur.

Whether or not the amount of interviewees was sufficient enough, saturation, which is one way to measure this, could be noted during interviews and the coding process (Kananen 2014, p. 95). There were similar type of answers to same topics in many cases.

Conducting only one more extensive interview round most likely didn't provide all there is to the topics. Getting deeper understanding about root causes could have required several interview rounds at the same time preparing new more detailed question sets based on any open issues left from previous interviews. Also one interesting view missing from the results is the customers view, how the customer has seen and sees the process and related information in different projects. This is more likely to be possible if the review is conducted by a third party. Nevertheless the results in this research can be considered something that was probable based on the initial definition.

8.3 Key findings and conclusions

The conclusions will be introduced based on the defined research questions to describe how the results aligned to those and finally was an answer achieved.

1) *When projects fail to succeed during execution, what common issues can be highlighted, which could be taken in to account in the pre-execution phase?*

   According to the results that were gathered from interviews and company documentation, it can first of all be concluded that short term, tactical factors are most important means to measure success in ship design projects. Keeping the cost level of individual projects within budget can be highlighted as primary factor.

   Based on results from reviewed case projects it can be concluded that the assumptions done during pre-execution phase seldom end up as expected during the execution phase. The results indicate that there have been various type of issues noted during case projects which in hindsight could have been taken into account already during the pre-execution or at least there could have been a worst-case-scenario type of analysis done rather than trusting the assumptions. In future project opportunities it would be seen important that the below listed topics would be taken into consideration, further details can be seen in appendix 3 and 4:

- Budget definition
- Design guidance and requirements
- Collaboration with the customer
- Design prerequisites
- Change process
- Approval process

It is proposed that these issues should be handled by means of risk management, meaning that the probability and effect would be systematically reviewed during project sales and execution. Most critical is to make sure that sufficient actions are in place if it seems likely the projects run into the same issues. It is also proposed that a best practices specification should be created and attached to contracts and offers to minimize the amount of unclearly specified matters.

2) *How could the current process be developed to take the highlighted issues into account?*

The case company has an ISO certified management system and after reviewing current ways of working primary issue is the fact that the current working process doesn't support sufficient knowledge transfer between the pre-execution and execution phases, the sales process ends when contract is signed and execution takes over from there. No systematic handover is required, rather it is up to the parties to evaluate whether the handover is necessary or not. There is room for assumptions that everyone knows what is expected rather than taking the time to make sure the assumption is valid. For example depending whether or not the project manager is involved during the sales phase, can impact in the decision how deeply the situation is evaluated. Based on the results a proposal to improve the current pre-execution has been defined. While the previous pre-execution phase ends when the contract is signed, the new process would require additional steps to ensure that the handover is done in a systematic manner every time.

3) *Could the sales and project management software utilization be developed to improve the process?*

   There are modern software's used during the processes. The current situation is considered such that there could be seen potential to use the CRM software, Salesforce, to improve guide the process towards execution in a more systematic manner. There are already some general points highlighted in the system, however there was noted that the tasks would need to be aligned based on how the process actually goes in ship design projects and what is actually required at which stage. Its currently more a note to take into account, if seen necessary, rather than something that is acknowledged as highly important matter. Additionally keeping track of modifications to relevant cost and hour calculation factors during the offering process could be logged in the system to provide better visibility to all internal parties.

8.4 Novelty value of the results

Similar type of research to investigate issues within ship design project domain has not been done earlier, at least based on the literature search conducted during this research. Therefore the results can be considered to provide a novel insight about the matter. However at the same time it is good to remember that only one company has been reviewed and it doesn't mean that for example competitors are running in to same issues.

8.5 Generalization and usability aspects of the results

The results and the proposed solutions can be considered valuable information when aiming to improve the success of ship design projects. Thus, mostly due to limited time for this type of research it was not possible to actually measure whether the solutions provide any benefits or not. Projects are projects due to the uniqueness of individual projects and even though there were common results about issues highlighted between case projects, any future projects should be evaluated as a whole and not take previous experiences and recommendations as something that will ensure success.

8.6 Further research topics

This research was done for one case company, was related to its process guidance and how four case projects have been executed. Considering the topic from a broader point of view it would be highly interesting to evaluate the same matter but include more parties to the

discussion. For example conducting a similar type of research of one ship building project and evaluating the topic from both customer and all design suppliers point of view could provide solutions to improve the whole design process to ensure all related stakeholders are able to achieve sufficient knowledge during pre-execution negotiations to ensure successful projects. At the end of the day the goal should be that everyone executes feasible projects.

Another possible topic for further research could be related to the way the hours are currently calculated. The cost performance is a critical factor in ship design projects it could be interesting to evaluate more specifically how different design activities consume hours and what different ways there could be to measure design and project management performance. Especially if something does not go according to plan how much the current statistics include these type of hours and what is actually the division between effective design vs other hours. At the same time considering the accuracy of statistics used for calculation it would be necessary to pay attention how the hours are reported and what type of statistics there is available in the end.

9 SUMMARY

This research was done for a case company which, among other services, provides consulting and engineering services for the maritime industry. The objective of this research was to, first of all investigate common issues that cause ship design projects to perform unsuccessfully. Then, out of those issues it was then further investigated that could there be highlighted something that could be taken into account already during the pre-execution phase to ensure new projects don't run into same issues, or if they do, the project management would at least have the opportunity to acknowledge the issue in advance and make a plan to mitigate the impact, if possible.

To achieve the objectives, a qualitative approach was selected. Information about the current state was gather from interviews and company documentation. Four case projects were selected to understand how the projects had performed and highlight possible common issues. Information about the topic was gathered from interviews with project and sales managers. Official project documentation and statistics were reviewed to support the claims of interviews. Additionally the current way of working and guidance provided by the existing ISO certified management system was reviewed. Based on the results it was found out that there are issues that are common in projects and there could be possibilities to take the issues into account at an earlier stage. It was also noted that first the process needs to be such that enables sufficient information flow between different phase, which did not exist.

Overall it can be concluded that the objective of the thesis was reached. At the same time it is good to remember the pros and cons of qualitative type of research and used methods. The researcher has a major role to always keep in mind the various possible ways to interpret the results and try to do their best to keep as objective as possible. Another thing to remember is the limited time there is usually for any type of research. For a researcher with limited experience in research it is a constant learning period and during the writing of this thesis there have been several thoughts that how something could have been done in a different way than initially planned. You do the best selections in the beginning, which guide the work forward. These valuable experiences will be useful in possible future research activities the author takes part in.

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INTERVIEW STRUCTURE

1 General questions

1.1 Basic information

- Short introduction to the research topic. Session recording on.
- Name
- Experience at company:
- Role(s) in reviewed projects:
- Any comments about research topic how it might have been considered earlier?

2 Project specific questions:

2.1 General

- Short introduction about project in general: customer, vessel type ship owner etc
- Customer relationship, existing/new, how well customer requirements and processes understood?
- How contract was handed over to project execution?
- Key issues raised and agreed?
- Further communication agreed?

2.2 Scope

- Scope definition, how was defined? How reviewed? Complexity? (Rating 1-5, Simple-Complex)
- Deliverables how defined?
- Used references?
- How possible lessons learned taken into account?
- Initial information for the task, how defined and what was the expected level of detail? (Rating 1-5, Bad-Good)
- Software requirements understood? Required tools known?
- Contract technical terms: suitable or compromise? (Rating 1-5, Suitable-Not suitable)
- Approval of deliverables clear?
- Change management clear?

2.3 Time

- How did the schedule appear to be in general? (Rating 1-5, Flexible-Tight)
- Was initial plan prepared? Based on what information? By who? What tool?

2.4 Cost

- Budget review, (Rating 1-5, Flexible-Tight)
- How was the cost and price calculated? Used statistics? Based on?
- How is the cost divided to tasks (management/design/travel/consumables…?)
- Commercial terms: suitable or compromise? (Rating 1-5, Suitable-Not suitable)

2.5 Stakeholders

- Understanding of customer stakeholders and their support/required interaction during project?
- Understanding of other relevant stakeholders and their support/required interaction during project?

2.6 Resources

- How was own organization planned to be selected? Project/design manager, designers etc?
- Was the project manager involved during sales phase?
- Where sub-contractors supposed to be used in project?

2.7 Risks

- Risks reviewed?

2.8 Quality

- Quality expectations?

3 Processes

3.1 Discussion about the IMS and processes

- Experiences using the IMS?

		Project A	Project B	Project C	Project D
	Topic	*Assessment*	*Assessment*	*Assessment*	*Assessment*
PRE-EXECUTION PHASE	Offer revisions	2 revisions	4 revisions	3 revisions	2 revisions
	Time from RFQ to contract	5 months	8 months	2 months	8 months
	Time from contract to start of detail design	Started immediately	6 months	6 months	3 months
	Customer relationship	Existing relationship	New customer	New customer	Existing relationship
	Economic situation	Weak economic situation	Good economic situation	Good economic situation, full order books, rushed sales phase	Good economic situation
	Scope definition	Reduced from initial request, detail design for two disciplines	Reduced from initial request, basic and detail design for one discipline	Reduced from initial request, basic and detail design for two disciplines	Specific work package, detail design for one discipline
	Documentation provided for calculations	GA and the work scope specification	GA, a list of required basic design drawings, ship outline specification and the work scope specification	GA, a list of required basic design drawings, a list of reference basic design drawings and the work scope specification	GA and work scope specification
	Schedule	Preliminary schedule provided	Preliminary schedule provided	Preliminary schedule provided	Preliminary schedule provided
	Calculation methods	Based on GA, software licenses to be covered	Based on drawing list	Based on GA, software licenses to be covered	Based on GA
	Calculation references	D1 good reference, D2 not very recent reference	Good reference	Excellent reference	Good reference
	Contract type	Fixed price	Fixed price	Fixed price	Fixed price
	Competition evaluation	Demanding negotiations	Nothing specific described in interviews	Demanding negotiations	Demanding negotiations
	Involvement in basic design	Yes	Yes	Yes	Yes
	Foreign office included	Yes	No	Yes	Yes
	Subcontractors included	No	No	No	Yes
	Budget evaluation	Doubts about final hours	Estimated sufficient	Estimated sufficient	Estimated sufficient
	Scope evaluation	Not expected to cause issues	Not expected to cause issues	Initial info readiness considered to be exceptionally good, new software	Not expected to cause issues
	Resources competence evaluation	Competent design team expected to be available	Competent design team expected to be available	Competent design team expected to be available	Competent design team expected to be available
	Customer collaboration	Nothing specific described in interviews	Professional counterparties	Nothing specific described in interviews	Professional counterparties, budget comparison with customer estimated, initial information and work procedures reviewed
	Risk reviews	Not done	Not done	Not done	Not done
	Project manager involvement	Involved in sales and also responsible for D1 calculation	Not involved in sales	Not involved in sales	Not involved in sales
	Knowledge transfer and internal communication	No specific knowledge transfer process, was expected that project manager has required information	Taken care by the discipline manager, no communication afterwards	Review conducted between project, sales and design manager. The sales manager selected as project supervisor	Review conducted between project and sales manager. The design manager responsible for calculations selected as project supervisor

		Project A		Project B		Project C		Project D	
	Topic	*Issue*	*How taken into account in pre-execution phase?*	*Issue*	*How taken into account in pre-execution phase?*	*Issue*	*How taken into account in pre-execution phase?*	*Issue*	*How taken into account in pre-execution phase?*
EXECUTION PHASE	Budget definition	-	-	Inadequate reference used for hour calculation	Hour calculation was done based on information provided by the customer	Inadequate reference used for hour calculation	Hour calculation was done based on information provided by the customer	Delayed subcontractor agreement resulted in additional costs	The need for a subcontractor was taken into account in calculation, but the contract was not finalized.
	Design guidance and requirements	New guidance and modelling requirements, major differences to previous projects	Not expected to cause an issue, contract requires the supplier to follow customer instructions	-	-	Inconsistent design requirements based on opinions rather than common guides, causing drawing rejections	Not expected to cause an issue, contract requires supplier to follow customer instructions.	-	-
	Collaboration with the customer	New customer organization structure, new coordinators, inadequate support and communication	Not expected to cause an issue	Inadequate support and communication, inadequate software administration, third party design errors	Contract states that software administration is customer responsibility, otherwise no issues expected	Inadequate pace to solve issues, changing customer coordinators, inadequate software administration	Contract states that software administration is customer responsibility, otherwise no issues expected	-	-
	Design prerequisites	Readiness of initial information not sufficient	Contract states the customer is responsible to ensure that sufficient initial information is at suppliers disposal when agreed	Readiness of initial information not sufficient	Contract states the customer is responsible to ensure that sufficient initial information is at suppliers disposal when agreed	Readiness of initial information not sufficient, drawing list with 2/3 drawings not required	Contract states the customer is responsible to ensure that sufficient initial information is at suppliers disposal when agreed	-	-
	Change process	Customer unwilling to recognize issues as change work	Contract states that change work shall be mutually agreed in advance. Work that cannot be agreed in advance shall be done and compensation agreed afterwards	Change work neglected due to imprecise scope definition	Contract states that change work shall be mutually agreed in advance. Work that cannot be agreed in advance shall be done and compensation agreed afterwards	-	-	-	-
	Approval process	-	-	Approval process was not followed, customer extended the approval time	Contract describes the approval process	-	-	-	-

Appendix 4: Risk management of possible issues during ship design project execution

Topic	Identified Risk	Review during pre-execution	Probability	Effect	Score	Mitigation during pre-execution	Mitigation during the beginning of execution
Budget definition	Reference used for hour calculation is inadequate	What is the impact if the reference is proven inadequate?				Calculation basis to be described in contract.	The basis for calculation to be reviewed with sales to enable sufficient hour spend follow-up
Budget definition	External subcontractor agreements not completed	Are the necessary subcontractors agreements in place?				Preliminary agreements with critical partners to be in place prior final customer contract agreements.	Required contracts defined during sales to be reviewed
Design guidance and requirements	New design guidance	Has the design guidance been reviewed and understood?				Available information to be reviewed and interpretation to be described in the offer and contract. In case sufficient information is not available, case company own best practices for design specification to be attached to the offer and contract.	Guidance to be reviewed. Possibility to use earlier projects experiences to be agreed.
Design guidance and requirements	Inconsistent design requirements	Has the detail level of design guidance been understood? How much possibilities for customer opinions vs own design solutions?					Customer involvement during deliverable approval process to be reviewed and agreed. If no guidance exists how will experience based design be treated?
Design guidance and requirements	Compared to previous experiences additional items are required to be designed	Has the content of design (what shall be modelled and included in drawings) been reviewed and understood?					Summary of required design items to be listed, by size, by weight, by area etc.
Collaboration with the customer	New customer organization	Has the customer organization been reviewed and understood?					Stakeholder power and interest to be evaluated and communication to be aligned accordingly
Collaboration with the customer	Customer coordination support is inadequate	How well and who will be able to support in coordination from customer side?					Coordination response times and communication to be monitored during beginning and possible issues raised immediately
Collaboration with the customer	Customer software administration is inadequate	Does the customer have sufficient experience about administration requirements? How dependent we are on customers software administration?					Administration response times and communication to be monitored during beginning and possible issues raised immediately
Collaboration with the customer	Third party design errors cause problems	Have the interfaces with other suppliers been understood? Are we dependent on other suppliers design?					Dependencies with other parties to be reviewed
Design prerequisites	Readiness of initial information is not sufficient	Has the expected readiness of initial information been analyzed?					Initial information readiness to be analyzed prior engaging any further design resources
Design prerequisites	List of deliverables is not accurate	Has the expected contents of deliverables been understood?					Deliverables to be compared to design requirements and possible issues to be agreed with customer
Approval process	Approval process is not followed	Has the approval process, including timeline for handling been defined?					A diagram of the approval process to be created and reviewed with customer.
Approval process	Customer does not approve drawings on time	Who will approve the deliverables from customer side?					Issue to be raised immediately when noted
Change process	Customer does not accept valid change work	Has the change process, including timeline for handling been defined?					A diagram of the change process to be created and reviewed with customer, including example change cases.
Change process	Contract specification enables customer to include additional work	Does the contract provide the customer the opportunity to request additional work free of charge? What type of work?					Issue to be raised immediately when noted, sales to be included in discussions