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Preface

This thesis marks the end of my Master of Science degree in Industrial Economics at the University of Stavanger. This thesis has been written in the spring of 2014 on behalf of an external company that is in the thesis referred to as "The Company" due to confidentiality reasons. Due to the confidentiality reasons it is difficult to thank all those who supported me while I was writing this thesis. I would also like to thank my supervisors for the opportunity to write this thesis and for their time and guidance while working on the thesis.

Tor Øistein Sand Sigbjørnsen

Stavanger, June 2014

Summary

The Oil & Gas equipment on the Norwegian continental shelf is starting to get old and are in need for refurbishments and upgrades. The services regarding refurbishment of subsea XTs are therefore more and more sought after. With the extra work problems with the current way the contracts are handled in The Company gets more visible. The current contract structure consists of a standard refurbishment scope of work with the addition of at least one variation order throughout the duration of the project. These variation orders are identified mainly during inspection, as replacement parts and repairs are hard to identify before the tree has been examined.

This thesis consists of both quantitative and qualitative analysis of the current contract management and costs in XT refurbishment projects within The Company. These analyses are used to discuss the effects of standardizing the additional work, and on how it may be added to the contracts standard scope of work. The thesis is mainly concentrated on the work characterized as additional work in the projects, and the effect of standardizing that work into a lump sum compensation contract.

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Abbreviations

3rd party (third party)	Sub-contractor
ERP	Enterprise Resource Planning
NDT	None destructive testing
NOBO	Notification of budget overrun
PO	Purchase order
QC	Quality Control
QI	Quality Inspection
QU	Quotation
RFQ	Request for quotation
SOW	Scope of work
The Company (the contractor)	The service company analyzed in this thesis.
The Customer	A oil field operator The Company deliver services for.
VO	Variation order
VOR	Variation order request
WBS	Work Breakdown Structure
XT	Subsea Christmas tree

1 Introduction

In this chapter the background and structure of the thesis will be described.

This thesis will mainly reflect the The Company's view from a contractors perspective.

1.1 Background for the thesis

The Oil & Gas equipment on the Norwegian continental shelf is starting to get old and are in need for refurbishments and upgrades. The services regarding refurbishment of subsea XTs is therefore more and more sought after.

The Company in this analysis is a large oil service company on the Norwegian continental shelf. As a services company in the oil & gas aftermarket, The Company is handling old subsea equipment that need to be refurbished and upgraded to today's standards.

The work regarding contract management in the projects is currently quite resource demanding. There is also some frustration amongst the project managers regarding how the current variation situation is handled, and the senior leaders are looking for possible solutions to this. One of the possible solutions to this problem could be to standardize the services prices offered by the company. Standardizing the prices may have a positive effect in several ways, but will also add risk and uncertainty to the projects. The current contract compensation format is a hybrid format based on lump sums, rates and cost +. This thesis will analyze and discuss the effect of standardizing prices by moving more towards contracts based only on lump sum compensations.

1.2 Structuring

Chapter 1: Introduction to the thesis.

Chapter 2: Consisting of a brief presentation of the theory that is relevant for writing and discussing this thesis.

Chapter 3: Consisting of a quick overview of the data collection and methodology with reference to methodology used in the thesis.

Chapter 4: Analysis on the XT refurbishment including handling of projects with variations and statistical data on costs in projects.

Chapter 5: Discussion of the analysis regarding standardization of prices and lump sum contracts.

Chapter 6: A short summary of what has been done in the thesis together with important observations. Suggestions on how to continue this standardization process have also been done.

2 Brief presentation of relevant theory

In this chapter relevant theory to the thesis will be discussed. Due to the theme of the thesis the relevant theory is limited and will therefore not cover everything that will be discussed in the analysis and conclusion in this thesis.

2.1 Compensation formats

Contracts in the oil & gas aftermarket industry are often based on several different compensation formats instead of just one. These formats are usually Lump sum, Unit-price, Hour/day-rate and cost-reimbursable. In Table 2.1 there is an overview of the different compensation formats with theoretical risk distribution and what the different formats usually are used for in the oil & gas services industry.

Table 2.1 Compensation formats risk allocation (from Tone Bruvoll lecture)

Compensation format		Risk allocation		Description
		Contractor	Customer	
Lump sum	Price / scope		Q * N * R	Used for compensation of one standard activity within a contract/job.
Unit-price	Price / pcs, m, etc.	Q	N * R	Used for standard spare parts defined in the frame agreement.
Hour-rate Day-rate	Price / hour Price / day	Q * N	R	Hour rate is used for compensation of hours. Day rates for work done offshore.
Cost-reimbursable	Contractor cost + fee	Q * N * R		Used for work done by subcontractor.

Q = Quantities

N = Norms

R = Rates

Table 2.1 shows a theoretical overview of the risk allocation for the different compensation formats often used by the oil & gas services industry. The description provides a short description on what the different formats are used for generally and in the contracts The Company have.

2.1.1 Lump sum (Fixed price)

Lump sum compensation is generally used when the scope of work is well defined. The way it works is when the customer agrees that the contractor has performed the SOW the contractor can issue an invoice on the agreed lump sum, no matter how much resources they have used to fulfill the SOW. In these scenarios most of the risk is on the contractor. Taking on more risk is often associated with higher prices. This kind of compensation format is usually best for standard jobs that the contractor has performed several times before. If the contract has a badly defined SOW and high potential of changes there is a high chance that the SOW has to be changed at a later stage. Changing the SOW through a VO or VOR is time consuming for both parties, and will be discussed more in chapter 2.6. The main benefits of this kind of compensation format are less risk of budget overrun for the customer and less use of resources used on the contract management through the project for both parties and therefore a theoretical lower total costs. If a contractor with a lump sum contract sees that he may not be able to perform the rest of the job according to his estimated budget, he may be tempted to make compromises to be able to stay within budget. He may take shortcuts and use materials of lesser quality to stay within his budget. This may then affect the quality of the finished product that the customer receives.

2.1.2 Unit-price

Unit-price compensation is often used when the specifications and work to be done is well defined, but the amount is not well defined. In the oil & gas aftermarket services industry this is often used for standard spare parts that has an agreed unit-price in the frame agreements. It is quite similar to lump sum, but has more room for changes in quantity. The risk in this format is mostly on the contractor, as they take the risk of doing the work at the agreed unit-price. However the customer still has the risk on the quantity ordered.

2.1.3 Hour/day-rates

Hour- and day-rates are normally used for offshore work and hour compensation that is supposed to give the customer value or work towards the scope. By using day/hour-rates the contractor can be sure that they get paid for the hour work performed. So the customer has all the risk of quantity and scope, but the contractor bear the risk of providing quality.

2.1.4 Cost + (Cost reimbursable + handling fee)

In the oil & gas services industry reimbursable compensations are often used when there is sub-contractor costs that is not part of the standard contracted SOW. This is often because the contractor don't have the required resources or knowledge to perform the task themselves and need to hire a 3rd party to perform the work. The customer will then compensate the contractor based on the invoice from the 3rd party and add an agreed percentage administration fee to the contractor's costs. Having such a contract may give the contractor the incentive to do it as expensive as possible, as then the fee will get higher the more expensive the 3rd party work is. This kind of contract is suited for a risk adverse contractor as they will always be paid the documented costs they have.

2.2 Incentives

Incentive is something that can be used in contracts to motivate the contractor to act in a way that gives the customer more value for the project. General incentive theory is that the contractor wants to minimize their own costs within the agreements of the contract. Where the customer wants to maximize their value of the project, and get the best quality for the lowest possible cost.

To give the contractors incentive it is important to give them more risk in the project. This can be done with choosing the right compensation format for the contractor. A contractor with a bad economy will generally be more risk adverse than someone with a stable economy.

According to P. Osmundsen(1996) the incentives should be based on three things.

- The incentives should be related to conditions that the contractor can control.
- The incentives should be measureable.
- Risk that does not lead to higher incentives should be eliminated.

By not following these principles the customer may give the contractor too much risk which may lead to the contractor demanding a higher risk award in the contract.

2.3 Frame agreement/framework agreement

A frame agreement is a contract between two contracting parties regarding the delivery of services or products. The agreement consists of a pre-defined list of services and products that the supplier is committed to supply within the agreed frames in the contract. By having a frame agreement the customer can issue an order from pre-defined agreements that do not need re negotiations for each order. The supplier has committed to a price and scope in the frame agreement and the customer knows exactly what they get for the price. In an oil & gas services products and services like mobilization/demobilization, spareparts and hour-rates are often specified and priced in a frame agreement with an operator. This makes it easier for both parties to give a quotation and issue an order on the service to be performed. The intention of using a frame agreement is to lower the administration and execution costs for projects by having preset agreements on scope and price for certain services and products.

2.4 Standardization

For the supplier to be able to commit to a frame agreement the products and services specified in the agreement will need to be standardized. If the contents of a frame agreement are not standardized the SOW may be unclear and disagreements between the supplier and the customer may arise. Products and commodities are normally easy to standardize. They have a cost related to the product itself and the cost of procurement. Services are another matter to standardize. Services do not have a pre-defined cost related to them. To be able to standardize a service one will have to be able to make the service similar each time it is performed. Statistical data as well as firsthand knowledge of the services may give an indication if a service is suitable for standardization or not. If the statistical data regarding a service is stable and predictable for the same work performed, it is much easier to standardize without adding too much risk. Standardizing the prices may not give an advantage right from the start. But if one can be more resource effective and still keep the same revenue, one will be able to get higher margins on the projects as time goes by.

2.5 The idea

As of today the contracts consist of several milestones where the contractor gets compensated for each of them delivered or performed. The contract may contain all the different compensation formats explained in section 2.1. The idea the company is working on at the moment is to standardize the services of XT refurbishments so that the contracts can have a pre-defined and lump sum compensation.. The main problem with this is that the scope often varies due to unforeseen repair or replacements after QC inspection of the equipment and parts. Therefore the damaged parts are added as variation orders in the middle of the refurbishment. The scope also needs to be detailed enough so that there is no doubt if the extra work performed can be interpreted as part of the main scope or not. If the scope is not detailed enough it may lead to big discussions between the contractor and customer.

2.6 Variation orders and variation order requests

Variation orders(VO) is an written update to an existing contract. The variation order describes the variation in the SOW that the contractor need to be performed, as well as the compensation and time schedule for the variation. Variations can be first initiated by the customer as VOs, but also by the contractor as a Variation Order Request(VOR). VORs are usually created when the contractor notices that the contracted SOW does not fit the actual SOW for the project.

In the services industry VORs are often used for the repairs and replacement of parts. When the contractor starts to disassemble and do quality checks on the equipment they may notice that some parts are not according to the requirements set by the customer. On smaller parts these deviations are usually best solved by buying a new part, but for bigger parts repairs are usually the best choice. When the contractor need to either replace or repair a part that was not specified in the original SOW they need to issue a VOR. The VOR will state which parts that need to be replaced or repaired for the equipment to meet the customer's requirements. The VOR will also have to state the price for the replacements and repairs. The replacement parts are priced according to the frame agreement between the customer and the contractor. The repairs are compensated according to a cost +fee format, where the contractor get compensated for the 3rd party cost they had.

2.7 Margins

Ernst & Young releases an annually review of the Norwegian oilfield services industry. This report is called "The Norwegian oilfield services analysis 2013".

The companies included in this report are Norwegian oil & gas services companies with at least 50% of its turnover generated in the oil and gas sector, Norwegian registered legal entity and the company annual revenues exceeded 20 million NOK at least once between 2008 and 2012.

The Company in this thesis mainly does services like refurbishment and modifications of equipment and tools used in the oil and gas industry. Therefore the "Operations" part of the analysis is best suited for comparison. In this analysis performed by EY the margin is given by EBITDA and EBIT. EBIT is the earnings before interests and taxes, while EBITDA is the earnings before interests, taxes, depreciation and amortization. Since this thesis is about specific project margins and not the company as a whole, the EBITDA margin is the most relevant. Table 2.2 is extracted from the EY report and shows the average EBIT and EBITDA from year 2008 to 2012.

Table 2.2: Average financial situation in oil & gas services companies, EY report

All values in million NOK	2008	2009	2010	2011	2012
Revenue	56 059	60 017	59 866	67 125	71 462
Cost of goods	14 200	13 728	12 450	14 886	15 983
Labor cost	18 011	21 370	20 670	24 851	26 700
Other Operational cost	13 562	14 395	16 516	17 828	18 494
EBITDA	9 960	10 168	9 950	9 272	9 997
Average EBITDA small company	14%	11%	12%	10%	12%
Average EBITDA medium company	15%	16%	15%	13%	13%
Average EBITDA large company	12%	7%	10%	6%	9%
Average EBIT	10%	7%	7%	6%	8%

Table 2.2: Average financial situation in oil & gas services companies, EY report above shows that an industry average for companies similar to The Company is 13%.

3 Data collection and methodology

This chapter will briefly mention the methods used in this thesis and why they were used. Also important assumptions, limitations and reliabilities of the data will be discussed.

3.1 Methods and data collection

According to (Holme, 1996) a method is a tool, a way forward to solve and get recognition on the research performed. All assets used to reach this goal can therefore be called a method.

There are two main types of methods, Qualitative methods and Quantitative methods. Qualitative methods are used to attain more understanding on the problem by the use of data that shows how complex the things you study are. Quantitative methods are more formalized and structured, often composed of statistical data.

This thesis uses both methods to cover both the statistical economic data as well as the thoughts of the people that work with these contracts on a daily basis. The quantitative method has been used to find statistical data regarding projects, to see if there is data that can be used for standardization. To be able to standardize prices without taking a too high risk, one need to be sure that there is good and trusting statistical data that can be used to set a correct price for the service. The qualitative method has been used to identify the problems and thoughts about the current contract formats.

To be able to get an understanding of the problems with the current contract formats as well as getting explanations for some of the deviations in the data from the projects, interviews has been conducted. The interviews have not really been structured interviews sent out to several people answering the same questions, but rather interviews that are more adapted to the data needed. It has been more of an information gathering and free flowing conversation than an interview. This has been done by talking to key personnel within the project management, bidding department, finance department and the department managers. These interviews can be characterized more like a conversation or discussion than an interview, where the candidate leads the interviews with their perceptions and opinions on the subject. Also instead of having one long interview with each person, several shorter interviews were performed as new questions emerged after interviews with other persons. The information from these interviews, as well as the writers own perceptions has played an important role to understand the current situation regarding the contract management and processes.

The question of standardizing services prices cannot be answered without having some statistical data in the background. The quantitative analysis has been conducted by extracting data from The Company's ERP software, SAP. The raw data extracted for this thesis is:

- Hour lists for the projects showing amount of hours by all employees on each project.
- Costs regarding sub-contractors showing all costs related to work not performed by The Company. Repairs, spares, coating etc.
- Full financial overview of the projects showing all revenue and costs registered on the projects.
- A project WBS showing structure of the projects in the ERP system. This was used to sort the data to which parts of the projects it belonged.

The data used for this part of the analysis cannot be used on its own to give a conclusion.

The data collected was done for 4-7 projects, depending on the type of data. The reason for the difference in project numbers for each analysis is that not all of the projects were finished at the time of analysis. Only 4 projects were fully finished and could be used for all the different data. Three of the projects were still ongoing so some of the data was not final yet. Instead of having only 4 projects to analyze the three ongoing projects were added to supplement on the data that was final in the projects. An overview of the data extracted from each of the projects is available in Table 3.1.

Table 3.1: Overview of data presented

	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	Project 7
Total finance overview	Yes	Yes	Yes	Yes	No	No	No
Total hour use	Yes	Yes	Yes	Yes	No	No	No
Additional work costs	Yes	Yes	Yes	Yes	Yes	Yes	No
Repair hours	Yes	Yes	Yes	Yes	Yes	Yes	No
Repair costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.2 Literature

The theory related to this thesis is quite limited. Theory used in the thesis has been obtained from the lectures and literature in the courses regarding Contract Management at the University of Stavanger. Together with this knowledge searches on the library's databases as well as wide searches on the internet has been performed.

4 Analysis of XT projects

In this chapter an analysis of the XT refurbishment projects will be presented. All the projects are based on the same contract type and compensation format.

4.1 Short introduction to the projects

The XT is a subsea structure placed on top of a subsea well and is used to monitors and controls the flow of oil or gas in the well. The tree type in this thesis weighs over 30 tons and consists of a total of 3131 components, stretching from the MVB weighing a few tones to small screws and bolts weighing a few grams. A rough sketch of a tree can be seen in Figure 4.1. In that figure you will also see the parts of the tree that has been identified as repaired parts in one of the 7 projects analyzed. There are up to 4 XT refurbishment projects a year for this kind of trees. And the same number or more trees will most likely be refurbished in the upcoming years. Therefore making improvements to the project process and contracts will give value to the upcoming projects.

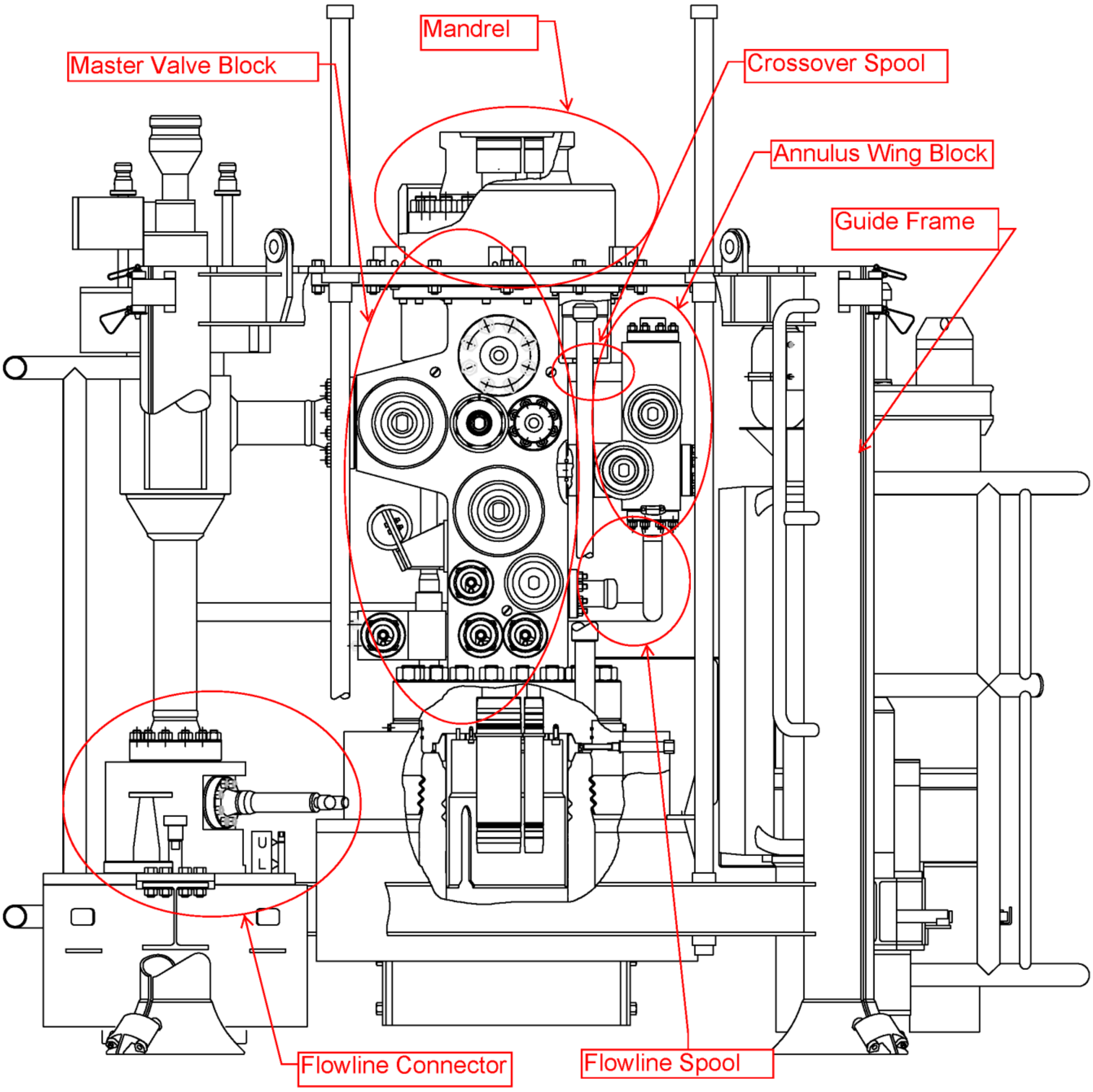

Figure 4.1: Subsea X-mas tree with common repair parts

4.2 How refurbishments of XT's are currently performed

One can divide the work of refurbishment into two main parts, the main scope and the additional work.

4.2.1 Main scope

The way these refurbishment projects are performed is that the main scope, the refurbishment, is divided into four stages or milestones.

The first stage is the "Strip clean and inspect". This stage consists of getting the XT into the workshop and strip it for all of the components. When the stripping is finished you can finally find out what kind of repairs and refurbishments that is required. Now the QI can start to check the major components for deviations from the requirements. After that stage is completed and the customer has agreed on the QI reports one can bill the first milestone and start on the next one.

In the "Refurbishment and upgrade" stage normal refurbishments and upgrades are performed by the company. But repairs on equipment showed in Figure 4.1, is usually performed by a 3^{rd} party that specialize in such repairs. Normal repairs are scorings in the seal areas that is critical for the system to work properly. These findings need extra work to identify the procedure to follow to repair the part. Smaller parts that normally go through a simple cleanup before reuse, but have gotten some damages that are not accepted according to procedures will have to be replaced. Normally it is only small parts that are impossible or more expensive to repair than replace. More on this will be discussed after the main scope. After the Refurbishment and upgrade is performed the company will get approval from the customer with reports on the work performed with measurements and inspections specified. The company can then bill this milestone and start on the next stage.

In the Assembly and test stage all the new, repaired and refurbished parts have come back and the assembly can begin. After the assembly all kinds of tests will be performed to ensure that the tree is able to perform as it should on the seabed. After the tests have been approved by the customer one can bill this milestone as well and start on the final documentation of the tree.

4.2.2 Additional work/VOR work

The additional work/VOR work is currently the work where the high risk lies. The additional scope that can be added to the PO is spare parts or repairs that are not included in the normal wear and tear, and therefore not included in the main scope. The additional scope is added as a VOR. These kind of additional scopes are normally set up with an hour rate for the personnel hours used on the identification and disposition of the repair, unit rate on spare parts needed and cost reimbursable for repairs done by any sub-contractors. The hour rates and unit rates are specified in the frame agreement

4.2.2.1 Repairs

The way items are identified for repairs are by a quality inspection. After the tree has been disassembled it is sorted into standard replace and refurbishment parts. The parts that are standard replace will be replaced by new parts, this can be due to changes in the material requirements or just that it is critical parts that are being replaced for safety reasons. The bigger and more expensive parts will be checked for faults and usually repaired instead of replaced. In the inspection they will look for visible cracks and dents in the metal, but also do "none destructive testing" which consists of a bunch of tests that will determine the tensile strength of the metal, the alloy components of critical areas and other weaknesses in the equipment. The deviations that is found will be noted and reported to the project administrators who then give the engineers the job to solve the deviations and make a procedure on how to repair it. Due to the fact that these parts are mainly heavy mechanical parts, welding and machining will usually repair the equipment back to the needed requirements. To replace a master valve block costs around 4 million NOK have to be expected, and the delivery time is very long. Same goes for the annulus wing block, 1,5 million NOK and mandrel 0,5 million NOK.

For repairs to be initiated one first need an accepted VOR that covers the cost of the repair. This often delays the repairs by several weeks as it has to go through the internal system and get accepted by the customer. According to the contract with the customer certain documentation need to be present to be able to invoice. The repairs have a cost + handling fee compensation format. That means that the 3rd party costs related to the repairs are supposed to be compensated. After having an accepted VOR and the costs has occurred the contractor can bill the customer. According to the contracts with the customer a 3rd party invoice has to be attached to the invoice to prove that the billed amount is correct. This makes the invoicing part of the repairs quite comprehensive.

4.2.2.2 Spares

In these projects there are two kinds of spares. The standard replace parts, and the quality control spares. The standard replace parts are identified and agreed upon with the customer on a general basis for several trees at a time. The prices of these spares are specified in the frame agreement between the customer and the contractor. Instead of having the standard replace spares bought for each project, a bulk of up to 4 projects will have their standard replacement spares ordered based on a separate contract. These contracts and spares will not be discussed in this thesis, in the future work it will be a good way to study the projects even further.

The additional spares are parts that have gone through a quality inspection and failed the requirements. For the contractor to meet the customer's requirements these parts needs to be either replaced or repaired. The smaller and less expensive parts will then have to be ordered to replace the damaged parts. These parts will then be included in a VOR to add the extended scope required to meet the requirements.

4.2.3 Hours/employee cost

The employee hours that get identified as additional work is work regarding the repairs or additional spares from above. This is hours used on procurement, logistics, engineer and project manager. The procurement hours are used to get contracts with 3rd party suppliers of spares or repairs, Logistic hours are used for preparing the part for shipping off to the 3rd party repairer, as well as controlling the shipping logistics of it. Project manager hours are used for coordinating the different the work to be performed on each project. The frame agreement only states rates for engineering hours and workshop hours, and not for the hours used on project management.

4.3 Compensation in current contracts

The projects in this thesis have varied in the way the main scope work the contract is comprised of. There are some differences on the milestone billings with "Assembly & test" and "MC Activities and documentation", where these milestones are missing in some project. Even though the projects lack a milestone sum for one stage, the total revenue is stable. This is because these are included in other stages instead. As you see in Table 4.1 the "Refurbishment & upgrade" in project 1 and 2 is split into "Refurbishment & upgrade" and "Assembly & test" in project 3 and 4. Project 1 however shows quite significantly higher revenue. The explanation for this is because in project 1 the actuators was refurbished, but in project 2,3 and 4 they were moved over to standard spares and bought on the standard spares projects and contracts instead.

Table 4.1: Contract values, revenue and costs for projects 1-4

	Project 1	Project 2	Project 3	Project 4
Revenue				
Strip, clean and inspect	1 202 711	1 202 711	1 202 711	1 416 264
Refurbishment & upgrade	4 792 604	4 701 481	2 662 663	2 357 676
Assembly & test	2 733 993	-	2 038 819	2 156 777
MC & doc	-	650 174	695 174	716 286
Additional work	890 435	744 172	1 197 311	1 592 706
Sum of revenue	9 619 742	7 298 538	7 796 677	8 239 709
Sum excluded additional work	8 729 307	6 554 366	6 599 366	6 647 003
Cost				
Employee	3 752 352	4 058 340	4 082 295	4 563 464
3rd party cost	4 746 086	1 979 253	3 645 898	1 783 097
rest	186 934	197 977	76 850	156 887
Total costs	8 685 373	6 235 570	7 805 043	6 503 449
Total costs excluded additional	8 101 566	5 470 083	6 443 878	5 364 346
Result	933 469	1 062 739	-9 222	1 735 459
Margin	9,70 %	14,56 %	-0,12 %	21,06 %

"Employee" costs are costs related to internal hours used on projects.

"3rd party" costs are costs related to ordered parts, repairs, coating etc. that is not performed directly by The Company.

"Rest" are mainly costs related to shipping of equipment for the projects, as well as all other costs that does not fall under the two mentioned above.

The average margin across these projects are 11,3%, which is 1,7% lower than the average 13% for similar companies.

In project 3 you can see that much of the reason for the project result to be that bad is the initial SOW costs. The reason for this was not identified, as the present project managers in The Company did not know the project in detail. But some of the explanation may be that it is additional work that was not identified as additional work. Another indication of this is the high 3rd party cost of project 3 compared to 2 and 4, where some of the costs there may not belong to the main SOW.

4.4 The contract process

This subchapter will give a quick overview of how the initial contracts and variations are handled between The Company and their customer.

4.4.1 Initial contract

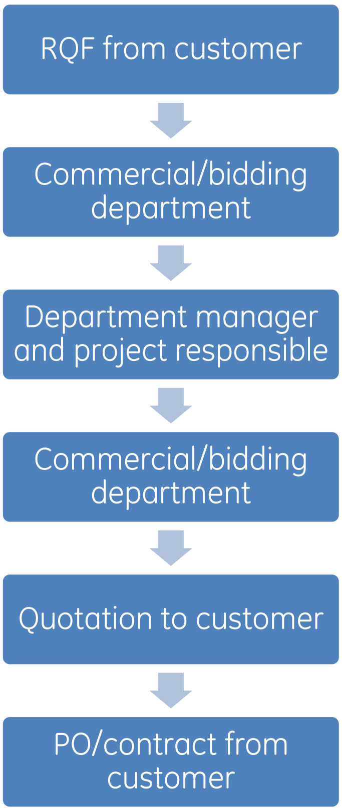

Figure 4.2: Initial contract process

First it needs to be clarified that these kinds of contracts are based on a frame agreement, and the company has very limited competition on these kind of refurbishments. The limited competition is due to intellectual properties such as drawings and procedures on the equipment. No other contractor is willing to bid on a project and give the customer a guarantee according that they will meet the specifications without having the drawings for the equipment.

The refurbishment contracts of the XT – trees start with the customer deciding that they will be pulling up a subsea XT that was originally made and delivered by The Company. They then send a RFQ to the contractor (The Company) where they request for a quotation based on the equipment and requirements stated in the request.

The RFQ is received by the commercial/bidding department which will make preparations and include the project department manager for the specific job category.

The department manager together with the project leaders then identify the changes in this SOW compared to the last and come up with a suggested scope. This is mainly based on experience from earlier projects, and not really any statistical data. Also a continuous discussion with the customer is being done to agree on a suitable SOW for the next trees. This means that the main SOW is constantly undergoing small changes. These changes and comments are then transmitted to the bidding department.

The bidding department then compiles all the data received on new SOW, new parts, time schedules and then sets up a "full cost" calculation which is the basis for the bid. Based on the costs they then add a suitable margin that reflects the risk taken but still is in the same ballpark as the former contracts.

The work that the bidding department do in these kinds of contracts is only registered on cost centers. When the hours are booked on cost centers it is impossible to extract the hours used on a specific contract bid. However an estimated use of 8-30 hours has been attained from the interviews performed. These 8-30 hours are hours used by the one person from the bidding department handling that specific contract. The reason behind the wide range in hours used is the complexity of the contract and the lack of feedback from the project department.

4.4.2 Variations

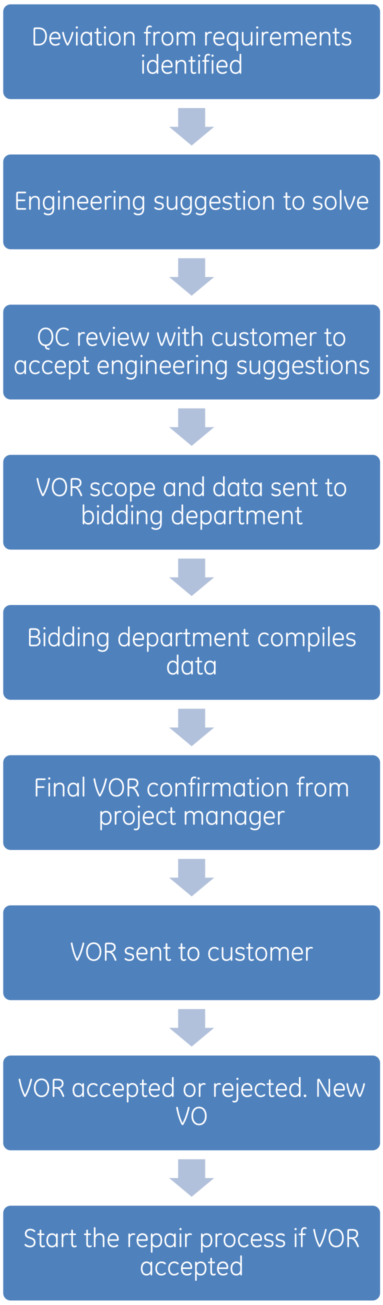

Figure 4.3: Variation order process

The variation order process usually starts with a deviation from the requirements. This can be damages to equipment that will result in a replacement part or repair of the part.

After the deviation has been inspected the details regarding the deviation is sent over to the engineering department. The engineers then analyze the damage and sets a repair procedure that will get the part back required specifications.

Next all the non-standard replacements as well as the repairs will have to get accepted by a technical representative from the customer. He will then confirm or reject the suggested actions.

The additional SOW is sent to the bidding department, and the procurement department starts to obtain prices on the repairs from 3rd party companies. The non-standard replacement spares already have a price in the frame agreement, so they don't need to get prices from the sub suppliers to make the VOR.

When all the data regarding the resource use for the additional SOW is available, the bidding department will compile everything into one VOR and send it off to the customer.

When the repair procedures are finished and the customer has accepted the VOR, the repairs can be initiated.

4.5 The resources used in the projects

The following sub chapters will show the analysis done on the resources used in the projects in this thesis. A general overview of the resources is shown, but the repairs have gone through a more thorough search for data. The reason for that is because of the unknown repairs that make the risk regarding standardization high.

4.5.1 Total hour use

Table 4.2: Hour use in the projects

All hours	Project 1	Project 2	Project 3	Project 4
Engineering	209,00	132,50	353,25	(917,00)275,5
Project management	1 093,50	1 191,50	922,75	981,85
Workshop	3 079,25	2 944,00	3 058,50	2 954,00
Total	4 381,75	4 268,00	4 334,50	(4 852,85)4211,35
Main SOW				
Engineering	172,25	107,00	338,50	236,25
Project management	1 025,50	1 161,00	871,25	937,85
Workshop	3 017,50	2 919,50	3 026,50	2 898,50
Total	4 215,25	4 187,50	4 236,25	4 072,60
Additional work				
Engineering	36,75	25,50	14,50	(670,75)29,25
Project management	68,00	30,50	51,50	44,00
Workshop	61,75	24,50	32,00	55,50
Total	166,50	80,50	98,00	(770,25)128,75

Table 4.2 above shows the hour use on each of the 4 projects that are finished. In project 4 there is original sum is in brackets while a lower sum of engineering hours are without brackets. The reason for this is that the data showed a very big difference in the amount of engineering hours used in the additional work, compared to the other three projects. Therefore a more thorough check of the hours was performed and a search for a reason to the huge amount of hours was done. After some interviews and digging in old project folders it was identified that 641,5 of these engineering hours were related to revision of procedures as a consequence of the customer updating their requirements. The revision of procedures is not something that is used only for that one project, but for all the upcoming projects as well. Therefore it would have been more natural so have a separate project for the revision. Because the revision of procedures is not that common, and that the work should have been performed on a separate project/contract, the hours regarding this work is removed from the total overview and shown in the brackets. Brackets show the total hours included hours used on the revision, where the hours without brackets show the hours used on the project itself.

If you look at the total amount of hours used on each of the projects there is only a deviation of 170,5 hours or around 4% from the highest to the lowest. This is the same case for the hours used on the initial SOW, which is a deviation of 163,65 hours or around 4% also. The additional work shows another story. The deviation from the highest to the lowest here is 86 hours which is a total of around 51%.

Table 4.3: Cost of hour deviations

	Hours	Estimated hour cost
All project hours	170,50	157 201
Initial SOW	163,65	150 885
Additional work	86,00	79 292

In Table 4.3 the deviations are calculated according to an average hour cost of 922 NOK. The deviation of 170,5 hours out of around 4300 hours may not seem that much, but when you take in consideration the direct cost of these hours it adds up to 157 201 NOK, which is decent amount of money when the margin gets added on top of that. This clearly shows some of the risk related to standardizing prices or contracts.

4.5.2 Additional work

Table 4.4: Additional work costs

	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Employee cost	237 041	163 223	338 015	625 342	161 590	354 725
Spares	235 706	451 044	428 671	439 565	2 141	32 676
Repairs	83 288	127 600	185 542	56 260	415 077	171 506
Harness refurb.					329 826	424 560
Other 3rd party	11 519	18 270	-	10 576	47 572	58 824
Rest	16 253	5 350	5 256	7 360	1 515	2 346
Total	583 806	765 487	957 484	1 139 103	957 721	1 044 636

The costs under "Other 3rd party" are costs regarding NDT testing, coating etc.

Table 4.6: 3rd party repair cost overview above shows an overview of the costs regarding the additional work outside of the main SOW. Most of the hours used on additional work is for repairs. From this overview you can see that there are deviations in all categories. But what really pops out in this overview is the "Harness refurbishment". This is an additional SOW that has been added from project 5 and after. This is a new SOW that has not yet been added to the main SOW. The Harness refurbishment consists of repair and refurbishment of cables for the sensors on the XT. The employee cost shows a quite big difference between the highest and the lowest. The highest is project 4, but as talked about earlier many of these hours were hours related to revision of procedures, and therefore not that important to study. The low cost of spares in project 5 and 6, compared to the other projects just shows how much the spares/replacements and repairs change from tree to tree.

4.5.3 Repairs

Table 4.5: Internal hours used on repairs

Part repaired	Project 1 hours	Project 2 hours	Project 3 hours	Project 4 hours	Project 5 hours	Project 6 hours	Project 7 hours
AWB	-	10	-	-	-	89	Hour use not final yet
Crossover spool	-	-	-	-	-	29	
Flowline connector	26	36	24	-	56	-	
Flowline spool	-	23	18	-	-	-	
Guide frame	-	6	-	-	-	-	
Mandrel	-	-	14	-	34	74	
MVB	11	5	21	89	55	91	
Harness	-	-	-	-	19	11	

Table 4.5 above shows the hours used on all of the repair jobs done in project 1 to 6. The hours mainly consist of engineering and project manager hours. Depending on the damage on the equipment the engineers may use few hours on an easy straight forward case, or several hours on some more serious and comprehensive damages. The engineer identifies the repair procedure, where the project manager coordinates the work that is used for the process of

getting the part from damage identified to repaired by a 3rd party. The hour use for the harness refurbishment should be next to nothing, and may be a sign of wrong hour booking. This is because there are no inspections done on these parts before they are shipped off to the 3rd party doing the repair. The hours registered for these repairs may be hours for following up the 3rd party, and making sure the parts have gone through a proper refurbishment. By comparing Table 4.5and Table 4.6 you see that the hour use often consensus with the 3rd party repair costs. Project 6 seems to have an average higher use of hours on each of the repairs. This may be because the damages were more comprehensive than usual, but the repair final repair procedure was not that demanding.

Table 4.6: 3rd party repair cost overview

Part repaired	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	Project 7
AWB	-	6 380	-	-	-	53 998	-
Crossover spool	-	-	-	-	-	17 400	-
Flowline connector	83 288	44 080	40 600	-	160 283	-	15 080
Flowline spool	-	17 400	17 400	-	-	-	-
Guide frame	-	49 300	-	-	-	-	-
Mandrel	-	-	127 542	-	96 802	45 008	105 792
MVB	34 800	31 320	62 060	56 260	157 992	55 100	94 424
Harness refurb.	-	-	-	-	329 826	424 560	607 469

The hour use for the harness refurbishment should be next to nothing. This is because there are no inspections done on these before they are shipped off to the 3rd party doing the repair. The hours registered for these repairs may be hours for following up the 3rd party, and making sure the parts have gone through a proper refurbishment.

Table 4.7: Repair cost estimation

Part repaired	Probability of repair	Average repair cost	Max repair cost	Average hour cost	Max hour cost	Long run average cost	Long run max costs
AWB	28,57 %	30 189	53 998	47 262	85 300	22 129	39 799
Crossover spool	14,29 %	17 400	17 400	27 486	27 486	6 412	6 412
Flowline connector	71,43 %	68 666	160 283	32 467	51 283	72 238	151 119
Flowline spool	28,57 %	17 400	17 400	5 534	21 214	6 553	11 033
Guide frame	14,29 %	49 300	49 300	5 534	5 534	7 833	7 833
Mandrel	57,14 %	93 786	127 542	38 173	71 096	75 405	113 507
MVB	100,00 %	70 279	157 992	42 116	87 034	112 396	245 026
Harness refurb.	100 %	453 952	607 469	13 448	17 211	285 826	624 680
Total		800 972	1 027 055	198 573	348 947	770 366	1 199 410

Table 4.7 above is a combination of Table 4.5 and Table 4.6 and provides a overview of the average and max costs and hour use on repairs. The "Probability of repair" is calculated based on how many times the part has been repaired out of the possible 7 cases studied. This gives an indication of how often one can assume that there will be a repair on each part.

The "Probability of repair" is based upon how many times the part has been repaired out of the 7 possible times. The only part not based on statistics is the harness refurbishment. This is because these available workers do not have the proper competence to check these cables for damages, and it is agreed with the customer that they always should be refurbished.

Based on the current statistics the highest possible repair cost for one project will be 1 376 002 NOK, where a long run average cost will be 770 366 NOK.

4.6 Possible lump sum calculation

Following below will be a quick and easy lump sum price calculation based on average costs in the project analyzed and long run repair costs in Table 4.7.

Table 4.8: Lump sum price

	Quantity	Average cost
Cost margin needed	10 %	
Risk margin	6 %	
Average hour cost	922,36	
Average hours used	4177,9	3 853 528
Average main costs		2 331 776
Long run average repair cost		770 366
Average spares cost		264 967
Average other costs		35 699
Total costs		7 256 335
Cost margin needed		725 634
Risk margin		435 380
Total lump sum price		8 417 349

Table 4.8 shows a quick and simple calculation of a lump sum price. Most of the costs are based on average costs from the other analysis's earlier in the thesis, and will only give a rough estimate of the costs needed. For less risky and more precise price estimation more work and statistics on the project costs will be needed.

Table 4.9: New price calculation vs. old

	Project 1	Project 2	Project 3	Project 4	Average
Sum of revenue	9 619 742	7 298 538	7 796 677	8 239 709	8 238 666
Sum costs	8 685 373	6 235 570	7 805 043	6 503 449	7 307 358
Result	934 370	1 062 968	-8 366	1 736 260	931 308
Margin	10 %	15 %	0 %	21 %	11 %
Result with standardized price	-268 024	2 181 779	612 306	1 913 900	1 109 991
	-3 %	26 %	7 %	23 %	13 %

Table 4.9 above shows the effect the lump sum price calculation might have had on these contracts. Project 1 will get a much lower result, but all the other projects will get a higher end result. The average margins would rise from 11% to the market average of 13%. To be able to meet this 13% market average a total of 16% for cost and risk margin had to be added to the costs in Table 4.8. The 16% is not a really a value that has any risk calculations behind it other than being able to meet the average of 13% that the market has.

5 Discussion

In this chapter different approaches to an easier contract/project management will be discussed. These approaches consist of different compensation formats to give the best incentive and the easiest process for both customer and the contractor.

What will be discussed the most here is the standardizing of repair prices into a lump sum.

5.1 Standardizing in lump sum contracts

By standardizing prices the company will have to move away from the reimbursable compensation currently used for the risky work regarding repairs and similar. And move towards a contract format that can make the contract management much easier if done properly. The main goal is to minimize the need for variation orders in the project.

5.1.1 Lump sum

The ultimate goal of standardizing the prices would be to be able to offer the whole refurbishment as one initial contract with lump sum compensation without having to update the SOW with any variation orders throughout the project.

There are several upsides and downsides regarding standardizing prices into a lump sum contract. The main downside of a lump sum contract would be the uncertainty regarding the variable work related to repairs, replacement of parts etc. shown in the analysis in this thesis. The data shows several deviations in the specific costs from project to project, but in total they are also quite similar. The closer you look into the projects the more different they are regarding costs and work performed. To standardize the prices based on current data one will be taking a higher risk due to the variations in the data.

The work identified as the most risky and unpredictable is the repair work. Before the tree has been stripped and inspected, there is no way of knowing what kind of repairs that needs to be done. The data on repair costs show that the repair costs for one project may need only one repair at the price of 15 000 NOK and the next one need several repairs at the cost of 500 000 NOK. To counteract this and minimize the risk in a possible lump sum contract limitations to the SOW may be added.

5.1.2 Efficiency

Another benefit of having a lump sum contract is that all improvement measures to the efficiency and resource use will give a higher margin in the projects. By having a lump sum contract the contractor basically gives himself the incentive to work more efficient. Not only does the contract give the incentive to work more efficient, but the contractor can work more efficient without having to stop the process up due to variations. Today's practice of repairs is that when the repairs are accepted by the technical representative of the customer the process of variations can start. To ensure that one always has expenses covered for one need an accepted VOR and updated VO to be issued first. This means that all repair work is at a standstill until the receipt of a VO that covers the cost of the repair is present. The time lost in this standstill varies from a couple of weeks to a couple of months, depending on the time it takes for the bidding department to make the VOR and the customer to accept it and issue a VO. When the VO is present one can finally start the process of ordering the repair work from the 3rd party, and ship the part off for repairs. By avoiding the process of VORs and VOs the projects may be more streamlined with less slowdowns. This will lead to less resource use on the contractual aspects of the projects for both the customer and the contractor; as long as it is within the SOW. A SOW should therefore have little room for interpretation. As having too much room for interpretations may lead to time consuming discussions whether the work is within the SOW or not. To minimize the possible ways a contract can be interpreted one need a clear SOW that both parties have a common understanding of. The SOW should be well defined, and reflect the standardizations the company can commit to at the present time. Work that is too risky or unpredictable to standardize should not be included in the SOW. The work with managing these standardizations and making sure they are up to date will be a demanding process. The saved resources with bidding and variations in contracts may have to be used to manage these standardizations. To minimize the risk one need constant updates of the statistics to ensure that you always have the latest information about the resource use for repairs.

5.1.3 Quality

In theory these kinds of contracts may also affect the quality of the final product. This is due to the contractors wish to maximize their profit on the project, and therefore choose the cheapest solutions. In this case however there are very strict technical requirements to the equipment that is used on the XTs. All parts need comprehensive documentation on origin, technical specifications and the repair work done. Meetings with the customers technical representatives ensure that all these requirements have been met before the customer accept the delivery of the XT. These strict requirements and controls limit the possible shortcuts the contractor can take, and therefore minimizes the customer's risk of getting a product of lesser quality than with another compensation format. Also as this is reoccurring projects with the customer the contractor gets an incentive to do a good job, so they don't lose the good relationship to the customer.

5.1.4 Customer perspective

People that are in regular contact with the customer representatives say that the customer has shown willingness to make alterations to the current contract formats and make the contract management process easier to handle. This may indicate that they are more willing to accept lump sum contracts, even with high risk margins added to them.

5.1.5 Scope of work

To minimize the risk as a contractor with a lump sum contract the contract need a well-defined and easy to understand SOW.

Another aspect to think of is the total cost if one of the repairs needed is not within the specified repair SOW. If the repair is not within the SOW, it is most likely an uncommon and expensive repair that will add a lot of extra cost for the customer. They will then end up paying for both the lump sum repair as well as the additional work outside of the SOW, where they normally would only pay for the additional work. E.g. several repairs are added to the SOW with a lump sum compensation of 1 million NOK. Only two repairs at 10 000 NOK and 500 000 NOK is identified, but the most costly repair is outside of the contracted SOW. In today's contract the customer would only have to pay the 510 000NOK + handling fee, but with a lump sum contract with specified repair SOW they will have to pay 1 million NOK and the 500 000 NOK + handling fee. But this is some of the risk the customer has to be aware of when agreeing to such contracts. This shows that some of the risk from standardizing the prices into lump sum repair prices may also be added as risk for the customer. But this is only if the SOW has been specified properly so that some of the risk will be transferred to the customer instead. So it is important that the customer is aware of the risk they take agreeing on lump sum compensations for repairs.

The contractor also have to keep in mind that they are bound to the contracted SOW. This means that if there is a repair within the SOW the contractor is obligated to do the repair no matter what the cost is. One therefore need to limit the SOW to be able to control what kind of repairs it covers so that it does not cover the uncommon and extreme repairs. These repairs are better handled as they are today with cost + fee compensation when they show up.

5.1.6 Risk

One common word mentioned in all of the above discussions is risk. The whole thing really comes down to the risk both the contractor and the customer are willing to take. Even though the contractor may be willing to take the risk, the customer may not let the contractor take the amount of risk. As mentioned in the theory giving the contractor too much risk will only result in a high risk premium regarding compensation. Because these are reoccurring projects, the best would be that The Company and the customer to have a good conversation on the risk they both are willing to take to make this process easier.

One can limit the risk in lump sum contracts in several ways. But most of them will add a higher possibility of a variation outside of the SOW needing VORs.

5.1.7 Statistics

To be able to set a less risky price, and have a more precise pricing one need good statistical data. At the present time the data available from the ERP software is not easy to analyze, and it may contain wrong cost allocations in the projects. Based on the writers own experience and indications from the interviews it is often that especially hours and spares are wrong in the projects. It may happen that hours are booked to the wrong parts of the project. This may be because the technicians doing the work in the warehouse or the engineers solving the repair procedures don't care that much about the WBS they book their hours on.

By standardizing the prices one need constant would need constant follow up of the services standardized. To make sure that the data used for the price estimation is still relevant.

5.2 The standardization of the prices in other compensation formats

The standardization can be done in several different ways. The one discussed earlier and the one The Company indicates is their wish to pursue is lump sum compensation. Other alternatives to a full lump sum contract will be discussed here.

Instead of offering services like repairs etc. as one lump sum compensation one can offer it as different "packages". By standardizing the and the price regarding certain SOW one can come up with a list of possible damage and repair situations with a unit price compensation for each relevant repair performed. To find a suitable unit price one would need to analyze the data on how expensive different kind of repairs are on the most common repair parts, as well as the other resources used to get a part repaired. Statistics for repairs and hour use will have to be quite comprehensive to be able to preset possible repair situations that could show up as repairs while refurbishing the XT. By standardizing it this way you are able to minimize the risk of taking a big loss on repairs. This way of standardizing it would be almost like the spares lists in the frame agreement, where the customer and the contractor have a pre-defined price for a given SOW. Adding these prices to the frame agreement would give both the contractor and the customer less work around administering this unforeseen additional work. As the customer agrees to which repairs need to be done, the contractor can quickly make a variation order based on the repairs identified. The invoicing of this would also be easier where documentation on what repairs performed is the only thing you need, and not having to attach 3rd party invoices like in the current compensation format.

Another possible way of making the contract management easier would be to include the variation hours in the main SOW and lump sum compensation. The hours used is something that can be controlled by the company and would therefore not be as risky as the actual repairs. The data shows that the hours used on variation orders vary, but also has a lesser total value. By adding these hours into the standard SOW it would be easier to make VORs and the invoicing of the VORs would need less documentation. As currently hours used on variations has to be documented by hour lists for the invoice to be valid.

These are just some of the possible ways one can standardize the services regarding refurbishment of an XT, and one could go on for ages with different combinations on how to do this.

5.3 Limitations in data and assumptions

Only the complete data was relevant for 4 projects. Earlier projects had a completely different scope together with the bad hour registrations meant that extracting relevant data was not possible without a high uncertainty. Therefore only Project 1-4 has all financial data. Project 5 and 6 are ongoing projects but in the late stages. Therefore the data regarding the repair work is final, and no more costs will be added. For the last project, project 7 only the 3rd party repair costs are available at this time. This is due to the fact that the project is in the mid stages and not all hours are registered yet.

This means that the repairs calculation has a data sample from 7 projects on repair costs and 6 projects on internal hours.

Projects before project 1 had a quite different scope, and consisted of refurbishing the XT, Tree Cap and the Tubing Hanger in one project. These projects therefore got excluded from the analysis as it was too time consuming and did not give much value towards the thesis.

The main limitation in this data is that it does not cover all possible deviations a part can have. Take an example. The next MVB that has some serious damages and need repairs done equivalent to 1 million NOK, which is nowhere near the maximum of 157 992 NOK from the statistical data. This is something to take into consideration. One may never see such a big repair cost to the equipment, but there is always the possibility that it may happen. This means that the data may not sufficient to give a precise estimate of the maximum possible repair cost.

Regarding Table 4.5: Internal hours used on repairs. The hours used for the repairs in project 6 was only booked to one WBS which made it impossible to track the actual hour use for each repair. An assumption has been done regarding the hours used on some repair jobs. It is assumed that that the price of the repair also reflects the difficulty of the repair, and therefore the need for more hours on repairs with higher cost. In other words the hours for the repairs on project 6 was distributed according to the cost of the repair. This may give an impact to the long run average cost, but it should not be that high.

6 Conclusion, suggestion and further work

There is currently some frustration amongst the project managers about how the current variation situation is handled, and the higher ups are looking for possible solutions to this. One of those possible solutions may be to standardize the products and prices that the company offers.

The research in this thesis on the XT product segment has mainly been concentrated on the additional work not included in the initial SOW. The additional work usually consist of repairs and additional replacement parts. The analysis has shown that the data available to compare is quite limited, and therefore adds risk to the standardization. To be able to compare more data one need to go further back in time, to get a better overview of the most common and possible repairs and variations to projects. It will consume a lot of resources to be able to standardize the prices for all product segments. But after it is done the first time it is easier to maintain and continue to utilize in future projects.

Standardizing the prices is an interesting idea which may give a lot of benefits regarding the contract management and the variation process in the XT projects. But in the end it is all comes down to how much risk the contractor is willing to take and how much risk the customer allows you to take.

My suggestion would be to pursue the idea of a lump sum contract including most of the common repairs and variations, making the need for VORs less common. To do this I would suggest having more focus on what kind of resources that is actually used to repair a part, and make sure the hour booking is done correct.

To make this standardization process less risky one need better data to be able to calculate what kind of costs one can expect from a normal project and its variations. Be able to do this I would suggest the following actions:

- Better hour registrations with focus on correct booking to projects.

- Financial/management summary in the end of the projects. What was special about this project? Were there a lot of hiccups?
- A precise overview of the correct amount of spares used on each project and the cost related to them.
- Obtain more statistics on repair costs. Maybe get 3rd party repair company to give prices on different kind of repairs.

A possible way forward is for The Company to come up with a bunch of possible ways some equipment may be damaged, make the repair procedures and ask for prices from the 3rd parties doing repairs. This will probably be a costly process both by use of internal hours to identify possible repair cases with repair procedures and getting the 3rd party to price all these repairs. But by doing this The Company will have better statistical data to determine a less risky standardized price and SOW in their contracts.

It would be interesting to see if the standardization is performed by The Company and how they choose to do it. I wish The Company great success in implementing this price strategy.

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Internal data:

- Frame agreement between The Company and customer
- Request for quote
- Quotations based on request
- Purchase orders
- Variation Orders
- Hours, finance and repairs from SAP

Internal interviews.