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PROFITABILITY ANALYSIS BETWEEN EPC AND EPCM PROJECT MODELS

Master's Thesis

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ABSTRACT

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<p>The objective of this Master's Thesis is to define the differences between EPC and EPCM project models in industrial construction projects and to examine if either one is more profitable. The study has been made from the point of view of an engineering consulting company who provides EPCM project services. The aim is to figure out whether the company should start providing EPC projects and what changes it would require.</p> <p>This thesis is a problem oriented research. Traditional qualitative research methods are used and also quantitative methods are used when collecting, estimating and calculating project cost data.</p> <p>As an outcome this thesis clarifies the differences between studied project models from different approaches and concludes that EPC brings better chances for bigger profits but with more risk. Also it figures out that the possible investment of implementing EPC project model to company's functions may be profitable.</p>	

TIIVISTELMÄ

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<p>Diplomityön tavoitteena on määritellä EPC ja EPCM projektimallien ja niiden kannattavuuksien ero suurissa teollisuuden rakennusprojekteissa. Työ on tehty EPCM projektipalveluita tarjoavan toimittajan kannalta. Tarkoitus on selvittää kannattaako toimeksiantajayrityksen siirtyä EPC mallisten projektien toimittajaksi ja mitä se vaatisi.</p> <p>Työssä on käytetty toiminta- sekä tapaustutkimuksen menetelmiä, joita ovat perinteisten laadullisten menetelmien lisäksi määrälliset menetelmät. Määrällisiä menetelmiä käytetään projektien kustannustietojen keräämisessä ja kustannuslaskelmissa.</p> <p>Työn tuloksena on selvitetty EPC ja EPCM projektimallien erot eri näkökulmista sekä on havaittu, että EPC mallilla on mahdollisuus parempiin tuloksiin vaikkakin suuremmalla riskillä. Myös EPC mallin implementoinnista aiheutuvat investoinnit voisivat olla tämän tutkimuksen mukaan kannattavia.</p>	

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I want to thank my family for all the support and tolerance, my colleagues for making the days at work superb and my friends who gave me space and work peace when needed or took me out to relieve my stress when I was going too loony. Last but not least, thanks to my little friend Donna who patiently followed my typing through nights and days.

Helsinki, May 25th 2018

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LIST OF ABBREVIATIONS

EPC	Engineering, Procurement & Construction
EPCM	Engineering, Procurement, Construction & Management
SWOT	Strengths, weaknesses, opportunities and threats

1 INTRODUCTION

The first chapter is the introduction of this thesis. The introduction is divided into five sub-chapters; background where the reason for this study is explained to the reader followed by the objectives where the main targets of this thesis are explained. The scope and limitations are told in the third sub-chapter followed by the theoretical and structural issues regarding this thesis.

1.1 Background

This master thesis is commissioned by an engineering consulting company who provides engineering, procurement, construction management and project management services in the industrial sector. The commissioner company will be called in this thesis as Company X. Company X has executed mainly EPCM (Engineering, Procurement, Construction & Management) formed project models in addition to basic design contracts. The supplier Company X has noticed that there is a need for EPC (Engineering, Procurement & Construction) project forms in some clienteles or projects. EPC projects, also known as turnkey projects, can be very challenging for the supplier as the supplier is more liable for the costs and risks in an EPC contract than in an EPCM contract.

According to earlier studies (Douglas 2016, Fieldfisher 2015) EPC is more favorable for the customer but on the other hand EPCM form is more convenient for the supplier. However EPC could be more rewarding for the supplier in a long term and therefore considered tempting as the supplier could influence more to its own profit. It is still ambiguous if either one of project models is more profitable in a long term observance. In chapter 2 the differences and advantages of both project models are gone through.

The Company X is considering adding the EPC project model onto its sales repertory but the true differences to EPCM must be studied first. After clearing the main differences between EPC and EPCM they should be compared on the level of costs, risks and liability. Only a theoretical comparison isn't enough and so an analysis has to be made using company's cost data on previous projects and therefor build a EPC cost data with the help of existing data and company's specialist knowledge.

EPC and EPCM contract forms bring also different values to the clientele and it could be said that depending on the client and on the market situation either one could be a more feasible choice to execute. Below a very simplified flow chart (Figure 1) where it is illustrated which model would be more feasible for the client.

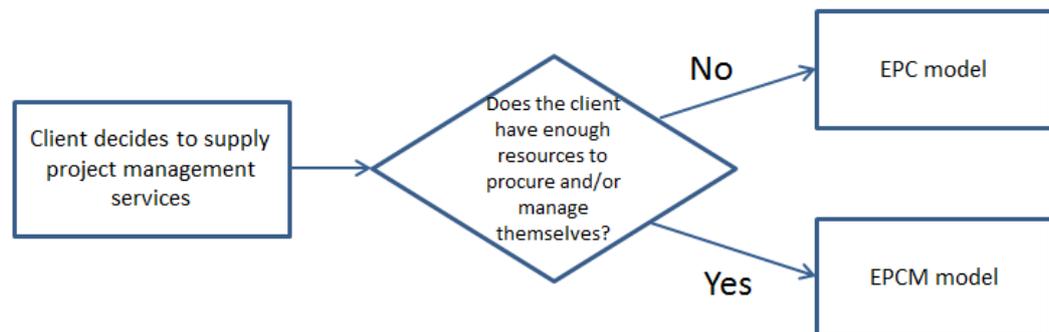


Figure 1. Which model should the client choose?

The project business, especially in the industrial field, is becoming nowadays more efficient, customer approached and at the same time more transparent between all stakeholders during the project. This is why different project forms should be compared also in different aspects than only from financial point of view.

1.2 Objectives of the research

The aim of this thesis is to find out whether either EPC or EPCM is more profitable for the supplier Company X or is there some factors which could make EPC more profitable or vice versa. Because studying only the financial aspects is not enough also risks and liability are compared between the studied models. The engineering consulting Company X is nowadays providing EPCM projects. Moving to EPC requires that the functions inside the company's project execution go through some changes. Some broad guidelines for the changes and to implement the new project model are also viewed in this thesis. More exact guidelines are performed to Company X as a separate document and they will not be presented as a part of this thesis.

As an outcome of this thesis there should be analyses about the differences between EPC and EPCM project models and the profitability of both models. A model to calculate the profitability in upcoming projects is one outcome which would remain for the use of Company X. Also the guidelines mentioned earlier are provided for the Company X's use when implementing the new project model.

From the academic point of view this study provides information about the differences in profitability of EPC and EPCM precisely in the industrial sector and from the supplier's or contractor's point of view. Same type of studies has been done earlier but from the client's point of view. This study could also be helpful to other engineering companies or to project owning companies which in this thesis are called clients.

The research questions act like pillars and ensure that the direction during this study stays the same constantly. The aim for this thesis is cut into three following questions:

- What are the structural differences in functions, cost models, risks and liability between EPC and EPCM?
- What strengths/weaknesses/opportunities/threats do the models have?
- What is the difference in the profitability between EPC and EPCM?

With the help of these questions it is possible to make a comparison between models and to make conclusions leaning on comparison and analysis. Also a recommendation on the most functional model for the usage of the engineering company is done.

1.3 Scope and limitations

The scope in this thesis will be limited within the Company X's project execution functions according company's confidential policy. The names and field of industry of the companies used in this thesis will be kept secret and all the financial and sensitive information will be scaled and corrupted to ensure companies' incognito. The original need for this thesis came from one client's need and situation so only this one client's project information is used in this thesis to ensure adequate usage of available information and data.

Request for this thesis came from commissioner Company X's procurement department and so the focus when examining the internal functions will be in procurement. Also positive and negative features that have an impact on procurement functions will be studied especially when changing from project model to another.

1.4 Research strategy and methodology

This thesis is a problem oriented research and case study type of qualitative research methods will be used. Quantitative methods are also used when estimating and calculating realized cost data. The qualitative part of this thesis involves literature, academic articles and interviews within the commissioning company. Large numerical data will be used but the calculations will remain in a basic level.

The results of this thesis are supportive for all type of companies functioning in project deliveries and also for academic world to bring a new view when comparing project models. Due to these features it could be said this thesis is a qualitative problem oriented case study research.

As told earlier this study's research method involves studying literature. The literature consists of books and academic publications on project cost engineering and profitability. The data used in the empirical part of the study is Company X's historical cost data. Data contains sensitive project cost data and therefore it is encrypted. Also some Master's Thesis' are used as backing knowledge and to support the building of this thesis's structure.

1.5 Structure of the thesis

The structure of this thesis work follows a classical thesis structure. First, in section 1 is the introduction; work's background is presented proceeding with the constitutive research information, as main targets, scope and methods used. Section 2 is the theoretical part of this study and it is divided into three parts. First it contains description of all the essential elements and terminology of project models to understand this study.

Secondly the models are compared from structural, financial and risk point of view. And the last part is focused in the theoretical profitability part of the study.

In the third section is the empirical case study where the calculations and analysis to solve the study problem are made. Also an example of the calculation model made for later usage is found in the section 3 as well as the results.

Section 4 contains a review of internal changes in different functions when implementing new project model to the business selection. The weight in this part will be on procurement functions. Also some guidelines for the company to start supplying EPC model will be given in the fourth section. After the fourth section the conclusions are presented including possible recommendations regarding applicable models. In the last section the summary of this work is presented.

2 EXECUTION PROJECT MODELS IN AN ENGINEERING CONSULTING COMPANY

Large-scale industrial projects in such as petroleum, chemical industry, rubber, metallurgy and energy are gradually increasing. These fields' features are complex technologies and processes besides the project requirements of high quality and short construction periods to achieve less investment. (Zhang et al. 2011, 1)

This section of this study is the theoretical part and contains the terminology and basic theory for the reader to understand this master's thesis with its problem and objectives. Later in this section the differences between EPC and EPCM project models are studied. Next the term of project is shortly explained followed with the examined project forms.

2.1 Project

The word project comes from Latin and means suggestion or plan. Shortly defined project is a group of people and other resources, who are joined together for a certain period of time to fulfill a specific mission. The project also has a fixed budget and schedule. (Ruuska 1999, 9)

Lockyer and Gordon (1996, 1) refer to ISO 8402 which defines project as follows:

"Project - unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources."

Lockyer and Gordon say this definition might be the best as it suits to a wide range of users.

Projects can be e.g. product development, research, designing, construction, delivery or a commissioning project. A project can be internally executed or an outsourced project when it is a consulting, construction or software company who manages the whole project execution or parts of it. In outsourced projects the project owner sets the project targets and chooses the supplier who executes the project. The supplier establishes a project organization and executes the project according the project plan. Every project has an owner who in outsourced projects is the person or company buying services from the supplier company. For the supplier the owner is called client or customer. In this thesis the term client is used. (Field & Keller 1998, 7; Eklund & Kekkonen 2016, 220)

Usually the terms execution project or delivery project are used. This is how the project is called from the project supplier's point of view. The supplier *executes* or *delivers* the project when the same project can be called investment project by the client because they on the other hand *invest* to the project. The terms of investment, execution and delivery projects are often used interchangeably but it is good to understand the difference.

In this type of execution projects there are three main settlement types for payment to choose from: fixed price contract, cost plus contract and the combination of these two (Pelin 1996, 202). According to Brahm and Tarziján (2015) the project complexity is associated with the increase use of cost plus contracts and the use on internal teams. In the next chapters this conclusion can be seen.

2.2 Project models

There are different types of project models an engineering consulting company can deliver but in this thesis Engineering, Procurement & Construction Management (EPCM) and Engineering, Procurement & Construction (EPC) are studied. According to Lampel (2001) the successful planning and execution of projects relies on the flexibility of EPC suppliers. It could be however concluded that this phrase applies also to EPCM suppliers. This flexibility and effective management depends on the acquisition of a set of core competencies which are required from the EPC or EPCM supplier. These core competencies divide in four groups: entrepreneurial, technical, evaluative and relational. The knowhow in every competence is crucial for accomplish success. EPC and EPCM project models are viewed more closely in the following subchapters.

2.2.1 EPCM

EPCM is an abbreviation from words Engineering, Procurement, Construction & Management. EPCM is a professional services contract where the EPCM supplier provides at least the activities listed below:

- Engineering: design and layout work according to the project.
- Procurement: supply of materials, equipment and human work (according to Engineering) that are needed to execute the project.
- Construction Management: Managing the construction site and that the budget and time are held in the project.
- Project Coordination: Manage and coordinate project to a successful project delivery. (Douglas 2016, 1)

EPCM is a worldwide known model, but the difficulty is that the meaning can vary between continents, countries, field of operation or even between companies. In this study the most typical form of EPCM is studied and consists the functions

listed above. Small differences the Company X applies are told in the section 3 where the case study is presented. A typical EPCM structure is illustrated below in Figure 2.

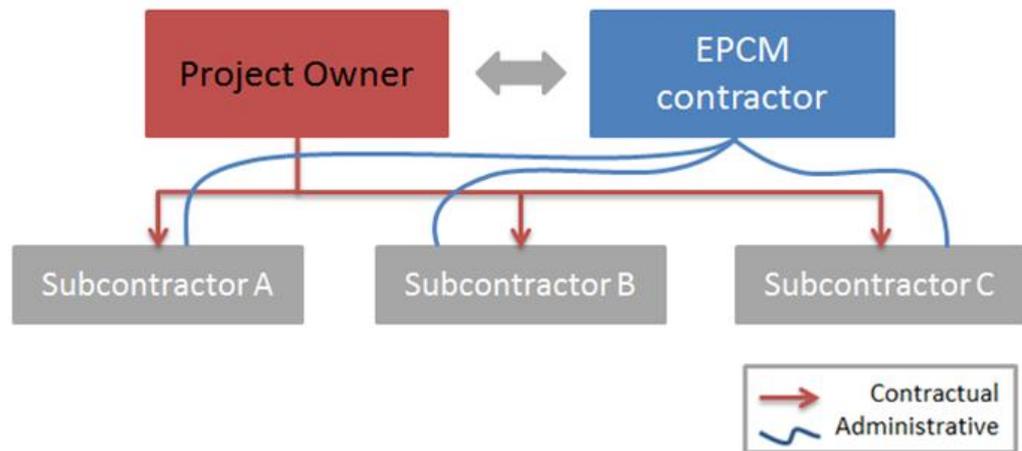


Figure 2. Structure of EPCM contract model (Fieldfisher 2015, 3).

In the EPCM model a cost plus contract or a fixed cost + cost plus contract are normally used. In cost plus projects the supplier reports the working hours to the project owner and charges the hours according to the contract. This type of contract is also called as open book contract. (Pelin 1996, 204)

In the combination of fixed cost and cost plus there is a specified part which is agreed to be done at a fixed price and all the additional work is done according to the agreed hourly prices. When bidding the supplier presents an initial estimation of the working hours needed in the project hence this is not completely indelible. Using EPCM contract the profit for the supplier might be minor but there is no risk. (Pelin 1996, 204)

The EPCM contract model has a few advantages for both parties, client and supplier. It may allow a fast startup of the project in some critical cases where the

technical data is not yet completed. Especially in unique technology projects this model is very suitable. In special projects there might come several changes to project scope during execution and this model may contractually allow these changes. On the other hand this contract is not very binding and in theory the supplier could lengthen the project schedule to grow its own profit. In practice this is very rare as suppliers want to maintain a good reputation and take new projects in the future. Also the project owner has to attentively guard the progression of the work and costs. The final price for the project clears out just in the late part of the project execution and the project might come out more or less profitable than estimated. (Pelin 1996, 204)

2.2.2 EPC

EPC is an abbreviation from words Engineering, Procurement & Construction. In this project model the EPC supplier is responsible for all activities to deliver the asset to the project owner. EPC is also known as Turn Key model, Lump Sum Turn Key or Design & Construct. In this thesis we will use the abbreviation EPC. (Douglas 2016, 1; Yescombe 2014, 164)

Normally a company who realizes they do not have sufficient expertise to manage or execute a project themselves decides to use EPC approach to ensure efficient execution. In an EPC contract the project owner expects the EPC supplier to handle all the activities and challenges during the project execution and then hand-over the key to the operation ready plant. Some believe this is the quickest, most cost-effective and surest way from the project owner's point of view to complete a project. But selecting a wrong supplier may change the situation completely, e.g. the project may be much delayed or the quality does not meet the requirements and the final price might be even doubled because of these. The structure of EPC is illustrated in Figure 3. (Choudhury 1988, 224-227)

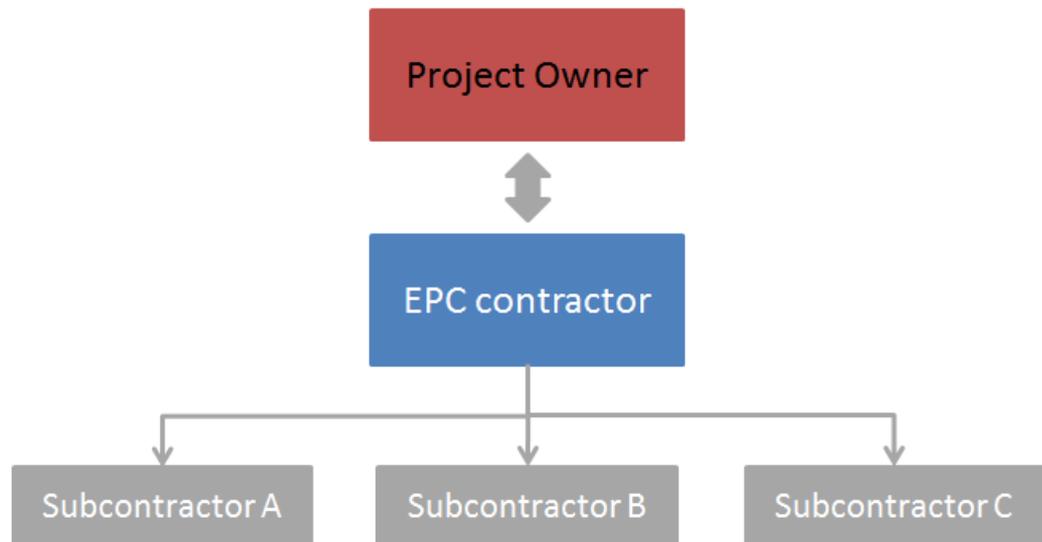


Figure 3. Structure of EPC contract model (Fieldfisher 2015, 2).

When using EPC fixed price contract is referred. The project is very precisely determined in the technical part of the contract. The supplier gains the profit by executing more efficiently than its competitors. The supplier however has the risk of undervaluing the amount of working hours and problems during the project. Therefore this risk should be added to the total price. (Pelin 1996, 202)

To the project owner the benefit of this model is to generate a competitive situation and choose the most affordable offer and hence drop the project costs. More than often it is said that a fixed price contract is the best for both project owner and supplier. It simplifies the project management as the project owner doesn't need to supervise the cost of every supplier's task. Also the supplier keeps motivated to execute the project financially and efficiently. Adding efficiency shows directly on the profit share. (Pelin 1996, 202-203)

On the other hand it could be that the supplier tries to maximize its profit by saving in the quality of the work and materials. This can be prevented by determining the technical details in the contract. If the project owner wants to make a change to the initial technical details the monetary value must be

estimated. Minor changes can be just logged and in the end of the project calculate the cost changes but bigger changes require a separate change order. (Pelin 1996, 203)

According to Ron Douglas (2016) EPC is a stronger option to deliver a project for project owners. EPC contract form provides advantages through an integrated team across the whole execution's life cycle. Long decision making, excessive approval processes and inefficient layering in tasks are eliminated. Below in Table 1 the advantages of both project forms from the *clients'* point of view are demonstrated.

Table 1. Advantages from client's point of view (Douglas 2016, 3-7).

Aspect	EPC	EPCM
Warranties	✓ One warranty between the project owner and contractor	Project owner has to negotiate with each supplier
Cost overruns	✓ Cost risk is borne by the contractor	Cost risk is borne by the project owner
Financing	Requires substantial down payment by project owner and all financing to be in order at the start of the project	✓ Any combination of down payments, accounts or letters of credit
Performance risk	✓ EPC contractor is responsible for all risk provided by contract	Risk is split between each contract and risk-sharing may become ambiguous.
Specialty work	Because EPC contractors usually work in high volumes there is no specialty know-how	✓ EPCM works better when specialty or unique qualifications are required
Procurement	✓ Cost savings by leveraged buying	Complexity, delays and change orders are typical to an EPCM profile
Performance measurement	✓ Reporting is unified with a single contract	Measuring tools can vary between contractors and complicate reporting

According to Douglas's study EPC seems to be more favorable to the project owner from different aspects as procurement, cost and performance control or risk and warranty issues. But EPC is an entirety which should have a clear scope beforehand to allow accurate cost estimation when bidding EPC contracts. So in projects where the scope is still unclear when startup EPCM is the only option.

For the supplier the EPCM model is more favorable when observing risk issues. Project's failure doesn't effect on the revenue of the supplier as the EPCM supplier provides only professional knowhow and work, not a completed project. But EPC on the other hand gives the supplier better chances to bigger profits and to determine the efficiency of own work. Differences and advantages between EPC and EPCM project models are demonstrated in following chapters.

2.3 Project Procurement

Procurement is an important part in the success or failure of projects, especially those concerned with equipment. The commitment for material, goods or services with a long lead time might need to be made even before the project team is in place. With a timely and clever made procurement, with the help of good frame contracts or successful tendering, procurement might be one cornerstone for a successful project execution. Therefore procurement is given more attention than perhaps usually in texts on project management. (Lockyer & Gordon 1996, 42)

The aim in procurement processes is to acquire equipment, software, materials, or services which are crucial for the completion of the project. In project management the word procurement is more commonly used than purchasing or buying as project procurement involves much more than just purchasing e.g. organization transport of material according to project schedule, documentation handling, financial revisions and hiring specialists or other services. Procurement

draws and brings information through several internal functions as engineering, project team and finance. (Lockyer & Gordon 1996, 42-44)

In project schedules procurement is usually just roughly represented. There might be entered only the expected delivery dates for equipment and materials. It must be highlighted that scheduling and supervision of procurement is an essential part of project controlling. The delays of suppliers and sub-contractors have to be minimized with efficient organizing, planning and monitoring. Usually there is a procurement department external from the project organization that is responsible for the procurement of equipment and services. This is the reason procurement is remained out of the controlling of rest project activities. Yet the control of procurement is distinct from controlling designing or construction activities. A project can have several of purchases that all have to be monitored even though not all have such a critical schedule towards the project. One procurement department's task is to determine how the different purchases are done and how they will be monitored. (Pelin 1996, 241)

Even though procurement of all the different functions is said to be the least fitted into a project organization it is essential that procurement is involved in the project planning since the early commitments. It is usual that the feasibility of the project depends on the delivery dates of articles and services. Good project procurement is sometimes such a demand that project owners may ask only for project procurement activities instead of e.g. EPC or EPCM. (Lockyer & Gordon 1996, 43)

2.4 Differences between EPC and EPCM project models

In this section the differences between the project models are observed. First the differences in functions are listed. Then on the following subchapters the differences are studied from different point of views like costing and risk issues.

In the last subchapter the features of the models are compared in a SWOT-analysis.

2.4.1 Functions

Like seen on the previous chapters the functions are mainly the same in both models. In EPC the supplier is liable for the whole project to be delivered in specific time and cost. In EPCM on the other hand the supplier provides the necessary services to complete the project.

Internally the functions in engineering, procurement, construction and management should be the same excluding that the cost and invoice controlling are in a more significance part in EPC than in EPCM to ensure company's sufficient profit margins and solvency. In EPC the supplier pays all the material and construction work providers' invoices meaning more work hours to the payables comparing to EPCM.

As said before the functions stay mainly as same but there comes some differences to the weight of work specific tasks. Collaboration between the supplier and the client are brought almost to zero when operating in an EPC project. The project is performed without any extra communication towards the client which narrows down working hours and tasks in all departments. The project manager of the EPC supplier is the only contact towards the client contrary to EPCM where different departments can have their contact persons also to the client.

2.4.2 Cost models

The differences in the project models' cost models are hard to distinguish because of several different possible contract forms. Still it can be assumed that the mostly used cost models are so called open book and fixed price.

Usually the open book model is used in EPCM projects where the client takes part to the project reporting through the project execution. Project meetings can be held e.g. weekly or monthly where all the project costs so far, pending costs, budgeted costs and possible overruns are reviewed. This way the cost reporting of the project is open to all project persons especially to the client's representatives. The only confidential cost information is the margin of supplier's working hours. Open book model is illustrated on below Figure 3.

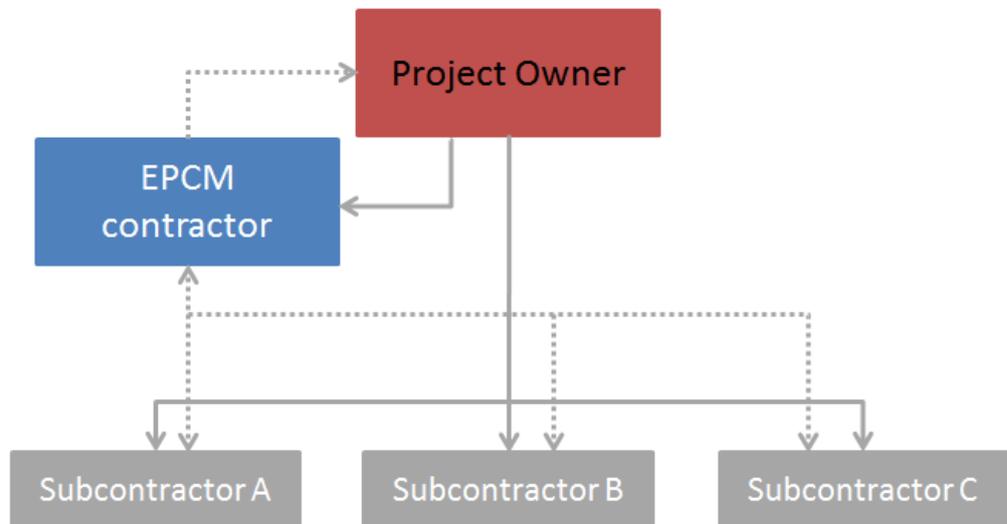


Figure 4. Open book model

In Figure 3 the solid arrows express the cost flows and dotted arrows information flows. The client (project owner) pays the invoices of the EPCM supplier and all the subcontractors. Yet the cost information is reported to the EPCM supplier

from the subcontractors and then to the client by the EPCM supplier. In practice the EPCM supplier reports to the client the projects costs, supervises them and advices the client when to pay the subcontractors.

Fixed price is used in EPC projects, where the total cost of the project is settled before starting the project. The agreed price is usually estimated by supplier's knowledge, experience and obtained quotations. Because the price is pre-fixed the supplier is responsible to track the project costs to ensure own project margins. In fixed price contract the costs are not usually reported to the client during project or even in the handover. Executed actual costs are only in the awareness of the supplier and can be used in bidding of following projects. The client is aware only of the price they agreed to pay.

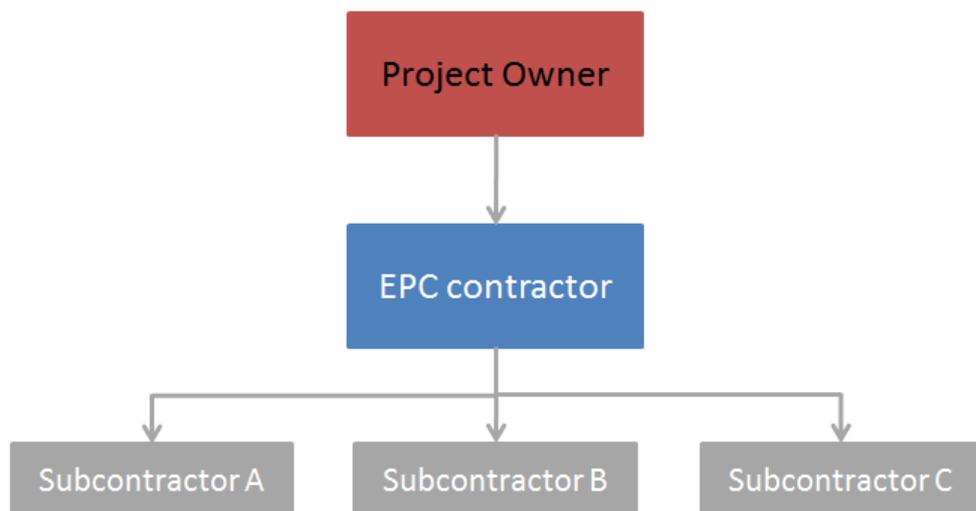


Figure 5. Fixed price model.

In Figure 4 the arrows express the cost flows of the project. The client pays a pre-fixed price to the EPC supplier and the EPC supplier pays to the subcontractors according to contracts and executed work through the project execution. The EPC

supplier does not usually provide any information of the subcontractors' final costs to the client.

2.4.3 Finance

Project finance contains the financial planning of the project through its execution. The projects Company X executes are large scale industrial projects and so they are also long-term projects. For long-term projects financial planning is essential to ensure financial preparedness through project execution. (Eklund & Kekkonen 2016, 225)

EPC projects are simpler for the client from the finance point of view comparing to EPCM projects. In EPC there are few pre-agreed installments which amount and schedule the client is aware of from the beginning of the project. In EPCM on the other hand the client has to be more flexible regarding its finance as the instalments agreed in the project contract between supplier and client are just estimates and can change significantly. It can be concluded that for the client EPC model is more convenient because its fewer installments.

From the supplier point of view there is also a difference in the finance of EPC and EPCM. In EPC the supplier has to be financially more flexible as it does all the procurement for itself and there are fewer installments it gets from the client. In EPCM procurement is made for the client in other words with the client's money. Also there are more installments it gets from the client, e.g. it can be agreed that the supplier invoices every month the working hours made. In that case the finance needed to pay supplier's own employees is also better covered. Below Figure 6 and Figure 7 which illustrate the finance of EPC and EPCM project models.

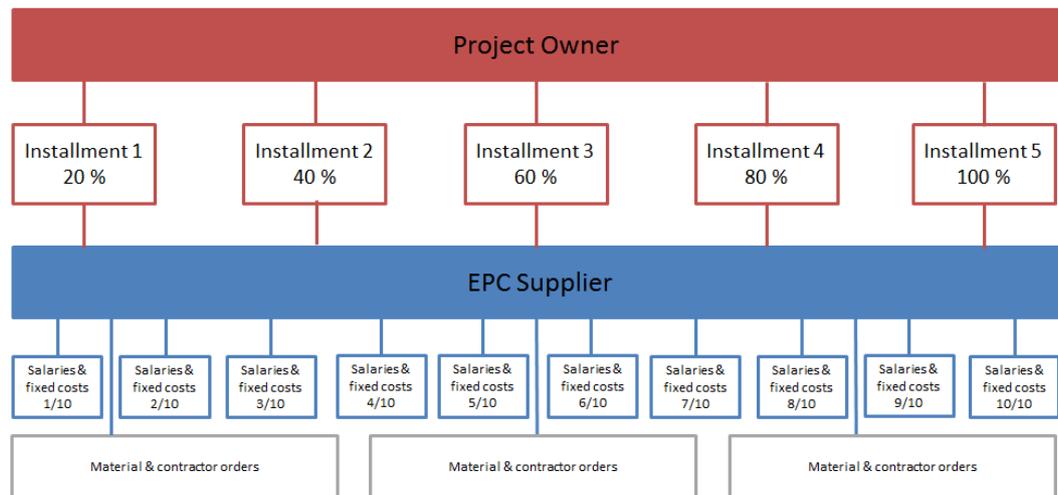


Figure 6. Example of the finance in EPC model.

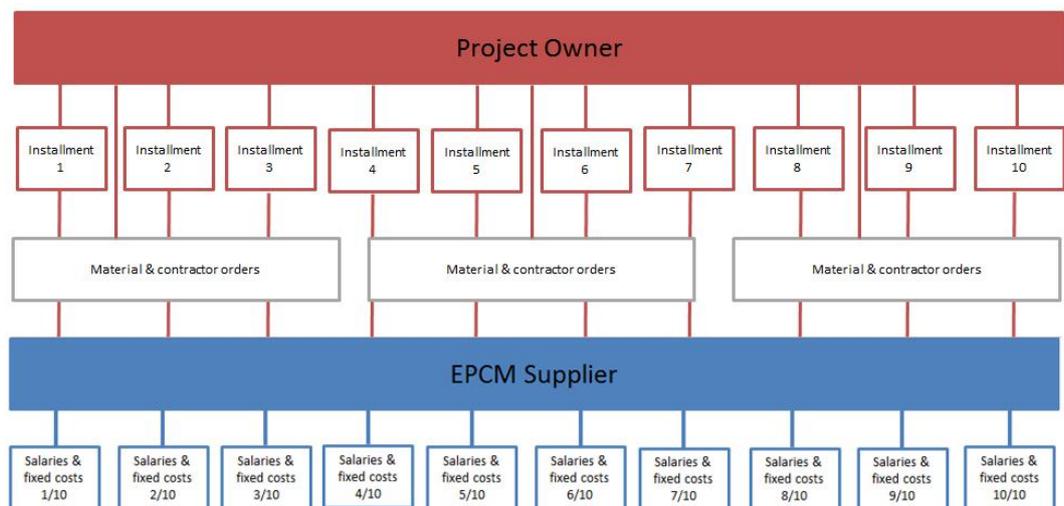


Figure 7. Example of the finance in EPCM model.

The examples illustrated above are very simplified examples of possible project finance structures. In reality the amount of installments and purchase orders is completely depended on project contract and project scope. Nevertheless it is clear that in EPC model enough liquidity and flexibility is required from the supplier to cover the costs in time through project. It can also be assumed that

small suppliers are not financially ready to operate in EPC model as it demands more finance from the supplier itself.

2.4.4 Risks

According to CHAOS data by Standish Group a high number of projects fail completely, are delivered late or are over budgeted. From 1994 to 2006 the share for succeeded projects increased from 15% to 35% when failed ones decreased from 35% to 20%. However projects which have faced challenges have stood more or less for 50% for all the tracking period. Even though there is a good knowledge of project concepts, management, and tools it seems like the occurrence of unforeseen events is the major reason for project failure. (Hillson 2009, 13)

These unforeseen events are probably partially unforeseeable but the rest are likely knowable. These knowable unforeseen events are called risks. Future events what would affect the performance of the project. (Hillson 2009, 13)

The term *risk* has multiple definitions; few of them are listed below:

- *the possibility that something unpleasant or unwelcome will happen* (Oxford Dictionary of English, 2003)

- *the possibility of financial loss* (Oxford Dictionary of English, 2003)

- *a hazard or dangerous chance* (Webster's Encyclopedic Unabridged Dictionary Of the English Language, 1989)

- *in relation to insurance contracts (a) the hazard or chance of loss; (b) the degree of probability of such loss; and (c) the amount that the insurance company may lose* (Webster's Encyclopedic Unabridged Dictionary of the English Language, 1989)

Risk management is a systematic process to identify, analyze and respond to any project risk. Usually only the negative consequences are being in focus but the positive consequences and their probabilities should also be considered. Risk management could be divided into six steps:

1. Planning
2. Risk identification
3. Qualitative risk analysis
4. Quantitative risk analysis
5. Risk response planning
6. Risk monitoring and control

In this study an overall risk analysis is not made but the steps 2-4 are gone through in some extent. According to Galli (2017) the focus in risk management is increased in project environments. Regardless of project complexity or situation, all risk management includes risk probability and impact assessment. A risk analysis studies the risks on project objectives, scheduling, cost and performance. (Galli 2017, 41-48)

In the case of Company X both project models have the same risks than any other project: problems with scheduling, legislation, cooperation etc. These problems can effect to the final completion. The client's approval or even the client's reputation is could be on the line due to quality or legislative issues. From the risks' point of view both project models have their risks, but the other one is especially financially more risky than the other. (Löow 2002, 59; Pelin 1996, 257)

The biggest risk in any project is completion risk which indicates the work may not complete within the agreed price, within the agreed time or to the required quality (Hosie 2007, 3). Both project models have risk to completion but the more matters are agreed in the contract the more narrow is the leeway and so there is more risk to carry.

In Company X's case we examine two different types of strategies. EPC is a higher risk strategy meaning potentially higher reward but also bigger potential of loss. EPCM is on the other hand a low-risk alternative with lower reward but also lower possibility to significant losses. These reveal the relationship between risk and reward which is illustrated in Figure 6. (Hillson 2009, 15)

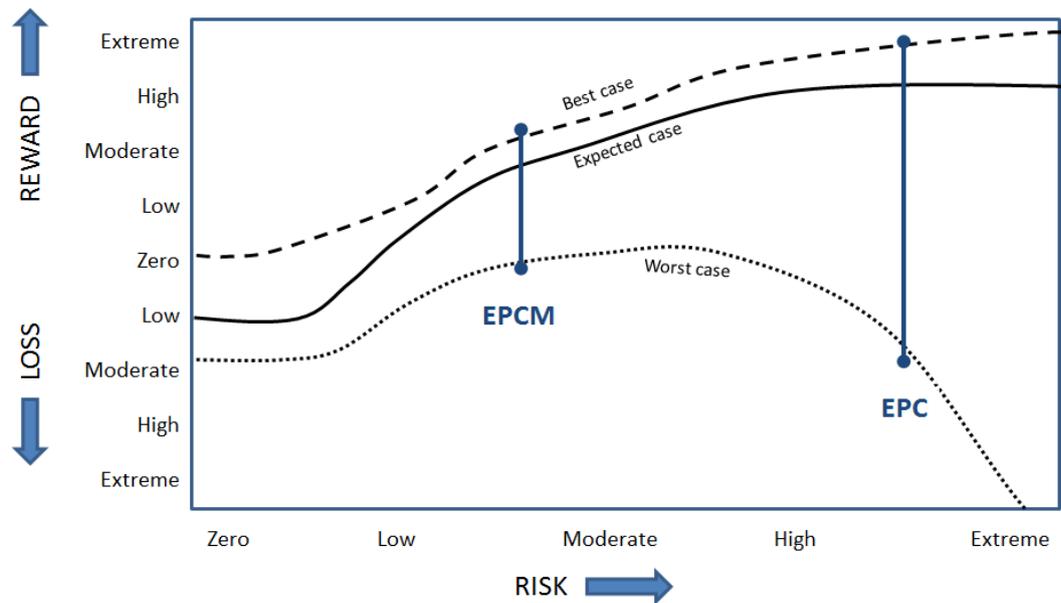


Figure 8. Relationship between risk and reward/loss in projects (Hillson 2009, 16).

In the EPC project model the final project costs are to be paid by the supplier itself. If the EPC supplier agrees to deliver the project at certain price and the final cost exceeds the agreed price, the supplier itself has to pay the price difference. This is crucial to the supplier because it effects to profit margins and thus the whole company's profit. On the other hand if the final project costs go under the agreed price the supplier gains so called extra profit. If the project is executed well and the client is content the relationship between the client and supplier improves and the client is more likely to choose this supplier again to a new project execution.

To gain profit in the EPC model all possible tools and connections have to be used. Tracking of costs, schedules and quality needs to be made at the best methods. Cooperation with partners and subcontractors needs to be proficient enough to ensure best prices, quality and loyalty. If there appear problems in any of these there is a risk that the EPC supplier is forced to pay the losses caused of these.

In the EPCM model on the contrary the financial risk concerning the project's final costs is not so brutal. The client holds the risk of the final project costs but either way the supplier is in charge of its own work. The baseline in any project, no matter what the delivered model is, is that the project is executed well, the supplier can be proud of the work done and the client approves the executed entirety. Below in Figure 9 the risk transfer in both project models is illustrated.

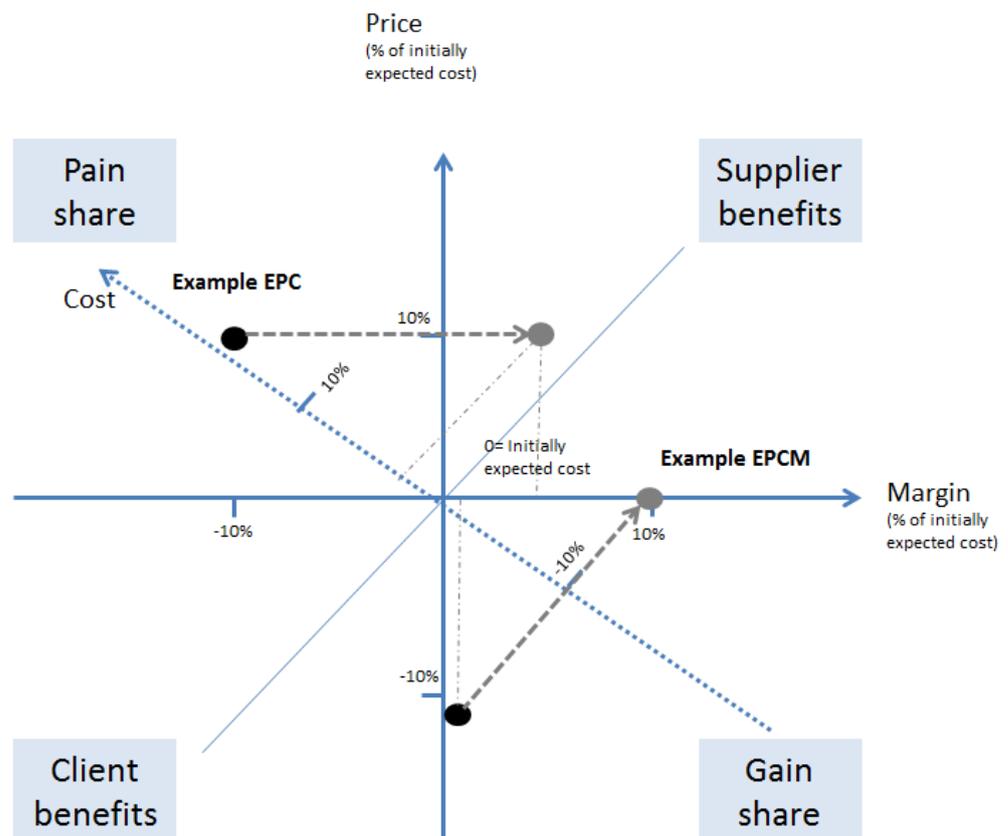


Figure 9. Representation of consequences from risk transfer (Witt 2012, 93).

In the figure it can be seen that in EPC project model the final price is set so the variables are true project costs and the supplier's margin. Changing the margin to a higher value the costs need to go under estimated and if costs surpass estimated the supplier suffers from a smaller margin.

In EPCM the costs could be said to be set because the information of costs is transparent towards the client and so there is no possibility to manipulate the size of the costs. In EPCM the variables are the final price and the suppliers gained margin. Basically the margin is set already in the beginning when the contract is made as the working hour prices are set then. Meaning that there is not a possibility to effect to the margin or profit throughout the project execution. Depending on how the variables change it can be seen how the risk transfers, in other words who ends up paying.

In projects there are also financial risks during the project. These are the risks which could realize in planning, procurement, execution and handover. These risks could be e.g. problems with designing, project planning, contract preparing, purchasing, deliveries, document management and finally handover. Because EPC project model is a more self-governing entirety than EPCM, there is also more possible risks in all these areas during project execution.

2.4.5 Liability

In EPC contracts the supplier is required to prove the reliability and performance of the completed project. There are several key areas: How to deal with the unforeseen ground conditions? How to address the design liability risks? Other areas are testing and completion. For example it is said that even though the project owner provides information of the project, the supplier is responsible for verifying and interpreting that data. According to this the risk of harmful ground conditions is allocated to the contractor. In the same way the supplier is required to take full responsibility for the whole design work. (Hosie 2007, 1-6)

However in very special occasions where there is an exceptional circumstance of which the supplier could not have known the time or time and cost impacts are migrated back to the project owner. This type of circumstance is called force majeure. (Hosie 2007, 9)

Another exception is when limitation of liability is applied. This is when the project owner is obligated to pay the supplier the loss of profit when the supplier is entitled to terminate the contracts because of project owner's default. (Hosie 2007, 10)

These are the mainly used liability lines but fortunately liability in projects is set in the project contract. It could be yet said that in EPC project models the liability plays a big role and should be studied well before starting to operate as EPC.

2.4.6 SWOT analysis

In this chapter the models presented previously are compared using the SWOT analysis framework. The SWOT analysis is a tool for strategic planning and it is used by companies to clarify the project's objective. It helps identify the factors related to the negative and positive into four areas: strengths, weaknesses, opportunities and threats. The key purpose of SWOT analysis is to identify the strategies which could create a business model specific to the company by evaluating the internal potential and limitations and the external opportunities and threats. (Osita et al. 2014, 23)

Both EPC and EPCM project models are put inside the same framework but clearly demonstrate which statements belong to which model. Below Figure 5 where the strengths, weaknesses, opportunities and strengths of both models are illustrated from the Company X's point of view.

STRENGTHS		WEAKNESSES	
EPC	EPCM	EPC	EPCM
Accuracy Chance for bigger profits is high	Accuracy Transparency More secure	High risk Challenging to manage	Chance for bigger profits is low
OPPORTUNITIES		THREATS	
EPC	EPCM	EPC	EPCM
New clientele Revise and improve functions Increases inner efficiency	Be the best supplier in the field	Risk Execution management problems More competent competitors	Less clientele Competitors

Figure 10. SWOT analysis of EPC vs. EPCM from the Company X's point of view.

Observing the SWOT analysis it can be concluded that it is not possible to determine straightaway which model is so called better. Both models have their pros and cons. It can be said that supplier's knowledge and experience determines a lot. Company X does not have experience in large EPC projects and that fact itself is a threat. But moving to a new type of operation model in any kind of business is always scary and has its threats. The decision has to be made by evaluating the positive incomes to the negative issues.

In the strengths and opportunities of EPC are listed a lot of things what would better the functions and success in any business. After all better profits and bigger market shares are what any company should aim towards. As said both project models have their positive and negative things and a possibility to operate both models in favorable shares in the company could be considered.

2.5 Profitability of execution projects

The more profitable is the business or in this context the project, the more profits are gained. Profit is a compensation of risk the supplier is ready to take. If the revenue is less than costs there would be losses. The project would be unprofitable if the supplier would have to carry the losses. (Tomperi 2011, 18)

Profitability can be indicated as monetary profit or loss from a certain time of period which is called absolute profitability. Larger projects should produce more profit than smaller ones. To compare the profitability of different sized projects profitability percentage is useful. The profitability percentage is useful also when the development of supplier's total profitability is monitored. Profitability calculations are used for decision making in businesses and that makes it an important part in any business. (Tomperi 2011, 18; Pellinen 2006, 52-53)

2.5.1 Project cost engineering

Project cost engineering is about cost controlling through the life of the project and it is a crucial function during the project. One of this function's tasks is to make sure the project comes profitable. A cost overrun could effect to a reduction of profit or even a bankruptcy. The procedures depend strongly on the type of contract being carried out. In a cost-plus contract the focus is on controlling costs rather than minimizing them. In a fixed-price contract however the costs are being held as low possible. (Lockyer & Gordon 1996, 75)

2.5.2 Opportunity costs

Opportunity costs are helpful for understanding the costs for the choices made for upcoming activity. Opportunity cost means the lost profit as a result of a made choice which could have been gained if chosen differently. In other words opportunity cost is the value of a lost possibility. (Pellinen 2006, 59, 71)

A cost is understood like a sacrifice and the central interest of business leaders is to hold the required sacrifices as small as possible to achieve a certain goal. (Pellinen 2006, 71-72)

Opportunity costing is considered the most relevant when decision making. Even though the concept is very workable in practice the exact quantification of opportunity costs is challenging. Company X's opportunity costs of moving or not moving to operate projects as EPC are studied in chapter 3.(Pellinen 2006, 203)

2.5.3 Investment's profitability

To acquire a new function in a company an investment has to be made. The fundamental formula to calculate investment's profitability is:

$$\text{INVESTMENT'S DIRECT PROFITS - DIRECT COSTS + REMNANT} \\ = \text{DIRECT MARGIN}$$

Figure 11. Profitability of an investment.

The direct profits of the investment are all the profits which aren't gained without making this certain investment. Remnant is the sales value after investment's life time. This formula will be observed in chapter 3 when the investment to acquire EPC model in the business is studied. Also cost effects and results of possible changes in functions are thought in the next chapter. (Pellinen 2006, 170-171)

3 CASE STUDY: PROJECT PROFITABILITY EPC VS. EPCM

In the empirical part different project models are observed from the financial aspect. Used cost data is from three projects Company X has executed as EPCM. The projects are EPCM projects that have been submitted to one same clientele. The projects are all of the same type and therefore very comparable. The final costs of the projects were calculated based on supplier's work hours and various purchase orders. Next the costs are compared with the original hourly estimates that were used at the bidding stage. Profitability is then calculated on the basis of the company's average gross margins and project specific fixed costs. The EPC scenarios used in this study are built on EPCM project data using expert assumptions on the changes of cost structure.

3.1 EPCM Projects

The three EPCM execution projects are observed in this section. All three projects are similar and comparable. True financial data is covered so percentages play a bigger role during this study. Projects are named in this thesis Project 1, Project 2 and Project 3. First the projects' cost estimates from the original quotations were studied and then compared to the projects' executed total costs which were collected from several systems in the company. On Table 2 it is illustrated how the estimates and final realised costs are divided into different activities.

In the Table 2 divisions of costs into different activities can be seen and some assumptions can be made based on this information. In every project the majority of realised costs, around 70% or more, are budgeted and also realised into purchase orders of material and contracting. In purchase orders contracting orders have a bigger weight than materials standing on average for over than the half of all the project costs. The next large expense is the working hours of project execution planning where engineering, project management and procurement work takes place. Percentage for these work hours varies roughly 15-24%. The rest of working hours allocates from project execution supervision work which has a portion of 4-6% or little more and other project costs which vary depending on every project but on average covers about 10% of all project costs in every project.

Further than noticing how the costs divide between different activities it can also be discovered that the percentage shares are broadly estimated right. Though examining more closely the real financial figures it can be said that there is a bit of inadequacy in the project cost estimation. Below a Table where the financial differences of the realised costs compared to the estimated are illustrated in percentages. A negative percentage means that the costs have been overestimated meaning that the realised costs have been smaller than budgeted.

Table 3. Financial differences measured in percentages.

	Project 1	Project 2	Project 3
Purchase orders	-13.0 %	-28.0 %	-25.0 %
Material	2.0 %	6.0 %	2.0 %
Contracting	-19.0 %	-41.0 %	-29.0 %
Working hours			
Project execution planning	-15.0 %	4.0 %	-15.0 %
Project Management	-65.0 %	-56.0 %	-40.0 %
Project Control	-52.0 %	-49.0 %	11.0 %
Process			
Process technology			
Automation Technology			
Electrical	15.0 %	47.0 %	-25.0 %
Instrumentation	-100.0 %	-63.0 %	-66.0 %
Piping			
Civil	-21.0 %	20.0 %	8.0 %
Steel Structures	355.0 %	257.0 %	
HSE Engineering	-66.0 %	-84.0 %	73.0 %
Procurement	-71.0 %	-48.0 %	241.0 %
Material & Equipment Procurement	-77.0 %	-73.0 %	-64.0 %
Purchase of services	335.0 %	244.0 %	-52.0 %
Delivery control & Inspection	190.0 %	163.0 %	-49.0 %
Invoice control			
Control System Engineering	-100.0 %		
Mechanical Engineering			
Project execution supervision	11.0 %	-24.0 %	2.0 %
Process Supervision			
Elect. Supervision	60.0 %	3.0 %	45.0 %
Instr. Supervision		-100.0 %	-100.0 %
Mech. Supervision		-100.0 %	
Civil	-46.0 %	-36.0 %	-5.0 %
Steel Structures	20.0 %	-100.0 %	
Construction Management	-24.0 %	-37.0 %	61.0 %
HSE Field Supervision	17.0 %	-76.0 %	-55.0 %
Warehouse	-28.0 %	-33.0 %	
Client's costs			
Vendors's costs			
Insurances			
Project Joint Costs (2,5-5 %)	-61.0 %	-67.0 %	-75.0 %
TOTAL	-21.0 %	-29.0 %	-28.0 %

In Table 3 it can be noticed that in some parts the estimation is not precise enough and would need some improvement. Especially the estimated costs of contracting are in all three projects overestimated. The difference from realised costs to estimated costs goes under between 19-41%. In Table 2 it was noticed that contracting stands roughly for almost the half of all project costs. Considering that in all three projects the half of project budgeting has been overestimated for approximately 30% it can be presumed that the total estimation of project is strongly corrupted because incompetent estimation of contracting.

That is why it can also be assumed that in contracting there is a chance to develop estimating and also there is a chance to gain profit when moving to EPC contract model. More of profit gaining by EPC model in next subchapter.

Observing the differences in the costs of working hours in project execution planning in Table 3 there are differences from +4% to -15%. Firstly project management is overestimated in every project and also project control is on average overestimated. In engineering there are changes to both directions and in all the procurement activities there are huge differences from -77% to +335%. The work hours of project execution planning stand for approximately 20% of all project costs when examining Table 2. Therefore differences also in this part of budgeting causes heavily wrong estimation in the total costs of the project.

The last parts are project execution supervision working hours and estimated project joint costs. In supervision hours there are some differences but when examining Table 2 these hours stand only for around 5%. Thus it could be said that hour estimating on supervision work hours is good enough.

The last part is project joint cost which contains costs from e.g. travelling, documentation copying and catering for meetings. In Table 2 it is noticed this part stands only for under one percent but according Table 3 joint costs have been overestimated in every project for over 50%. In the estimation of project joint costs might be a place of improvement probably just changing the formula of calculation.

Overall all three projects have been overestimated for 21-29% which is almost the third and it can be said that changes this large are not affecting the clients in a positive way in a long term. Of course in EPCM projects it is good news to the client if the project executes 30% cheaper than estimated. But in a long term if every project is overestimated it gives the client the image that the supplier is not capable to estimate the project costs right. In an ideal situation the history of estimations should be more around +/-10% in respect of the actual costs.

On the other hand Projects 1-3 are EPCM projects and it can be that in the beginning when the estimating was placed the project's technical details were not precise enough and that could be the reason for the overestimating. Nevertheless continuous overestimating is a sign of unskilled project cost estimating.

It might be that the cause for continuous overestimating is a penetrated way of acting which has been developed since several years. The knowledge of general project work, technology specific know-how and the use of systems and tools have almost certainly developed through years. Not forgetting to mention the universal development globalization and technologization has brought.

There are tasks in project work which are nowadays made more efficient with the help of modern tools and some tasks have even been completely removed for the same reason. These types of changes might have been forgotten to take into account in the process of project cost estimating.

Human behavior could also be a reason for the overestimating. To demonstrate the ability to perform better the overestimation might be done on purpose. Or there might be even calculated some allowance for a bit lazier inefficient work. These types of behavior are very humane and might be done completely unintentionally.

3.2 EPC scenario

Because the Company X did not have enough cost data on EPC projects three EPC scenarios had to be built based on actualized EPCM projects Project 1-3. These scenario projects are called in this thesis as Project 1S, Project 2S and Project 3S.

3.2.1 Building phase

The scenarios are built with the assistance of managers and specialists of different departments of Company X. The biggest changes are directed to the shares of purchase orders and working hours in project execution planning. But also to the rest parts some changes will take part.

As seen in the previous chapter the estimation of the share of purchase orders especially in contracting is not precise enough. When discussing with specialists it came out that when moving into EPC model, the EPC supplier uses its own general agreements. Until now when operating through EPCM model the used general agreements with suppliers and contractors were client's agreements. Having own general agreements with the frequently used service and material providers may have a positive impact to the gained profit. Therefore it is assumed that the actual costs of these expenses are lower when delivering EPC model project. The estimated costs of materials can be cut by 5% and contracting orders by 15%. These percentages will be called factors and they will be used when calculating a price for an EPC project. Factors per activities are seen in the next Table 4.

In the working hours of project execution planning changes would happen in all activities according to company specialists. Project management hours would remain nearly the same but reporting and cooperation with client would decrease a

bit. For the same reason the hours in project controlling would decrease as now one big task in project control is to create reports for the clients in addition to internal reports. Engineering hours would also decrease as there would be less cooperation with client because of more specific technical details and a more clear scope.

In procurement changes will occur to both directions. In procurement management at least in the beginning will be increased amount of working hours because of new general and frame agreements. Moving to EPC model a SRM (Supplier Relationship Management) procedure should be created and maintained so also the new SRM would increase procurement management hours. In other hand procurement activities working hours drop significantly because of own agreements with suppliers which leads to fewer requests of quotations, less comparison between quotations and ready-made order terms. Delivery control would be more efficient when the buying is done to the company itself but on the other hand the operative maintaining of SRM would be more likely one of delivery control's work task.

Table 4. Change factors per activity.

	Factor
Purchase orders	
Material	-10 %
Contracting	-15 %
Working hours	
Project execution planning	
Project Management	-5 %
Project Control	-30 %
Process	-15 %
Process technology	-15 %
Automation Technology	-15 %
Electrical	-15 %
Instrumentation	-15 %
Piping	-15 %
Civil	-15 %
Steel Structures	-15 %
HSE Engineering	-15 %
Procurement	50 %
Material & Equipment Procurement	-60 %
Purchase of services	-60 %
Delivery control & Inspection	-60 %
Invoice control	-100 %
Control System Engineering	-15 %
Mechanical Engineering	-15 %
Project execution supervision	
Process Supervision	-5 %
Elect. Supervision	-5 %
Instr. Supervision	-5 %
Mech. Supervision	-5 %
Civil	-5 %
Steel Structures	-5 %
Construction Management	-5 %
HSE Field Supervision	-5 %
Warehouse	30 %
Project Joint Costs	2 %
Project Allowance	7.50 %

Invoice controlling would not be done any more on behalf of the client but it will be done for the company itself and therefore this function would be moved from project execution functions to company's internal functions. That is why it will be completely removed from the project activities and what comes to possible revising invoicing of purchase orders with finance department it would be included to the purchaser's work tasks.

Project execution supervision hours would maintain almost as the same level. Only aspect to decrease hour amount in this section would be the fact of less cooperation with the client. The fact that in EPC model there would not be a demand to use client's own systems and tools, effects to every project working activity decreasingly.

Warehousing has been a minor expense in EPCM projects. Moving to EPC model brings the responsibility of all articles but also eases delivery control by operating with an own warehouse. Own warehouse increases the working hours in this section.

As seen earlier in Table 3 project joint costs have been every time overestimated, due to this the percentage used in estimation of EPC could be cut into half so it would be a 2 % share of all project working hours' cost. Also project allowance percentage could be fixed. In real life this would depend strongly on the project's scope but to simplify the calculations in this thesis a percentage of 7,5 will be used.

3.2.2 Factor input phase

In this section the factors decided in the previous chapter will be implemented to the initial estimation calculations. This way a price for an EPC model is generated and comparison between EPC and EPCM can be started.

Below Table 5 where the percentage differences can be seen after implementing the change factors.

Table 5. Price differences between estimated EPCM, realised EPCM and estimated EPC.

		Purchase orders	Project execution planning	Project execution supervision	Project Joint Costs	Project Allowance	Project Total costs
Project 1	Estimate	100 %	100 %	100 %	100 %	100 %	100 %
	Realised	87 %	85 %	111 %	39 %		79 %
Project 1S	Estimate	86 %	84 %	95 %	44 %	65 %	84 %
Project 2	Estimate	100 %	100 %	100 %	100 %	100 %	100 %
	Realised	72 %	104 %	76 %	33 %		71 %
Project 2S	Estimate	86 %	84 %	98 %	87 %	81 %	85 %
Project 3	Estimate	100 %	100 %	100 %	100 %	100 %	100 %
	Realised	75 %	85 %	102 %	25 %		72 %
Project 3S	Estimate	86 %	82 %	100 %	34 %	76 %	84 %

In the calculation of Table 5 the estimated price of EPCM project is the nominator when calculating the realised EPCM price and EPC estimate. Observing Project 1 can be seen that the realised project costs in total have been 79% of the estimated price. Using the factors generated previously a price for this project is gotten if it would have been delivered as an EPC model. The price for this fictional Project 1S would have been 84% of the initial estimated price for the EPCM project.

3.3 Evaluation phase

To have a better understanding of the percentages assumption can be made that the estimated price for all Projects 1-3 was 10 million euros. The estimated price is the price the supplier has sold the EPCM project contract to the client. So it can be said the client has agreed with this price in bidding phase. However the client has noticed the lack of cost estimation knowledge and knows that the actual price will most certainly be lower. This is the reason why the supplier has to offer a lower price when bidding EPC model.

When using the generated factors the price for EPC Project 1S is 8.4 million euros which is more affordable than the estimated Project 1 EPCM price 10 million euros. The actual realised price for Project 1 was 7.9 million euros and if this would be the actual price also for the EPC project the extra profit in addition to the work hour margins would be 1.5 million euros. The actual price for the EPC project cannot be known and probably it will be not 7,9 million euros, however a value must be decided to continue the calculations and by determining it is the same as the executed EPCM the following calculations are easier to comprehend. The hourly margins could stay as same in EPC project than in the EPCM projects. Below in Table 6 is illustrated the extra profit for every project if they would have actualized as same as the EPCM projects.

Table 6. Extra profit with respect of actualized EPCM figures.

	Project 1	Project 1S	Project 2	Project 2S	Project 3	Project 3S
Estimated cost	10 000 000,00 €	8 400 000,00 €	10 000 000,00 €	8 500 000,00 €	10 000 000,00 €	8 400 000,00 €
Realised cost	7 900 000,00 €	7 900 000,00 €	7 100 000,00 €	7 100 000,00 €	7 200 000,00 €	7 200 000,00 €
	Over-estimation 2 100 000,00 €	Gained profit 500 000,00 €	Over-estimation 2 900 000,00 €	Gained profit 1 400 000,00 €	Over-estimation 2 800 000,00 €	Gained profit 1 200 000,00 €

According to Table 6 the EPC(M) supplier could have gained an extra profit of 0.5-1.4 million euros if the projects would have been delivered as EPC projects and the project would have realised with the same figures. However in EPC

projects the true hour expense is different than in EPCM and also other variable exist. The material and contracting orders might be more or less expensive than estimated. Also in working hours might be changes to one way or another. To identify if there is truly a chance for extra profit different variables have to be taken into account.

A sensitivity analysis provides different outcomes by changing the values of independent variable. By changing the values of working hours and/or purchase orders up and down it can be noticed how these changes affect the final value, project's total costs. In Table 7 it is illustrated how the changes of purchase orders and working hours costs effects to total costs.

Table 7. Cost changes when changing variables of purchase orders and working hours.

Working Hours		Purchase orders						
		70%	80%	90%	100%	110%	120%	130%
		4 257 120,00 €	4 865 280,00 €	5 473 440,00 €	6 081 600,00 €	6 689 760,00 €	7 297 920,00 €	7 906 080,00 €
70%	1 187 760,00 €	6 066 480,00 €	6 674 640,00 €	7 282 800,00 €	7 890 960,00 €	8 499 120,00 €	9 107 280,00 €	9 715 440,00 €
80%	1 357 440,00 €	6 236 160,00 €	6 844 320,00 €	7 452 480,00 €	8 060 640,00 €	8 668 800,00 €	9 276 960,00 €	9 885 120,00 €
90%	1 527 120,00 €	6 405 840,00 €	7 014 000,00 €	7 622 160,00 €	8 230 320,00 €	8 838 480,00 €	9 446 640,00 €	10 054 800,00 €
100%	1 696 800,00 €	6 575 520,00 €	7 183 680,00 €	7 791 840,00 €	8 400 000,00 €	9 008 160,00 €	9 616 320,00 €	10 224 480,00 €
110%	1 866 480,00 €	6 745 200,00 €	7 353 360,00 €	7 961 520,00 €	8 569 680,00 €	9 177 840,00 €	9 786 000,00 €	10 394 160,00 €
120%	2 036 160,00 €	6 914 880,00 €	7 523 040,00 €	8 131 200,00 €	8 739 360,00 €	9 347 520,00 €	9 955 680,00 €	10 563 840,00 €
130%	2 205 840,00 €	7 084 560,00 €	7 692 720,00 €	8 300 880,00 €	8 909 040,00 €	9 517 200,00 €	10 125 360,00 €	10 733 520,00 €

According to Table 7 it can be said that the project costs tolerate better the changes in working hours than in purchase orders. A 10% increase in the costs of purchase orders exceeds the estimated cost of 8.4 million euros even though the working hours costs undercut 30% the estimated cost. On the other hand the total project cost goes under estimated even if the part of working hours exceeds 30% at which time the portion of purchase hours need to be reduced only by 10%. In the next Table a same type of sensitivity analysis has been made in according to the variables of project joint cost and project allowance.

Table 8. Cost changes when changing variables of project joint costs and project allowance.

		Project Allowance						
		70 %	80 %	90 %	100 %	110 %	120 %	130 %
Project Joint Costs		411 600,00 €	470 400,00 €	529 200,00 €	588 000,00 €	646 800,00 €	705 600,00 €	764 400,00 €
70 %	23 520,00 €	8 213 520,00 €	8 272 320,00 €	8 331 120,00 €	8 389 920,00 €	8 448 720,00 €	8 507 520,00 €	8 566 320,00 €
80 %	26 880,00 €	8 216 880,00 €	8 275 680,00 €	8 334 480,00 €	8 393 280,00 €	8 452 080,00 €	8 510 880,00 €	8 569 680,00 €
90 %	30 240,00 €	8 220 240,00 €	8 279 040,00 €	8 337 840,00 €	8 396 640,00 €	8 455 440,00 €	8 514 240,00 €	8 573 040,00 €
100 %	33 600,00 €	8 223 600,00 €	8 282 400,00 €	8 341 200,00 €	8 400 000,00 €	8 458 800,00 €	8 517 600,00 €	8 576 400,00 €
110 %	36 960,00 €	8 226 960,00 €	8 285 760,00 €	8 344 560,00 €	8 403 360,00 €	8 462 160,00 €	8 520 960,00 €	8 579 760,00 €
120 %	40 320,00 €	8 230 320,00 €	8 289 120,00 €	8 347 920,00 €	8 406 720,00 €	8 465 520,00 €	8 524 320,00 €	8 583 120,00 €
130 %	43 680,00 €	8 233 680,00 €	8 292 480,00 €	8 351 280,00 €	8 410 080,00 €	8 468 880,00 €	8 527 680,00 €	8 586 480,00 €

It is noticed that the same pattern repeats when observing changes in costs of project allowance and project joint costs. On the other hand changes are not so extensive because of smaller share in total project costs. Projects' total costs tolerate better the changes of project joint costs. An addition of 30% in joint costs is resisted if projects' excess costs undercut the budgeted allowance.

The sensitivity analysis provides the information to understand which features have a bigger weight on the total costs. From the profitability point of view the analysis can also be used to calculate in which parts the focus should be when improving efficiency.

Because purchase orders stands for 70% of the total costs going over estimated is immediately effected on the profit. This underlines the fact that moving to operate EPC model procurement is in a huge role to secure competency and project profitability.

3.4 Profitability analysis model

Even tough financial and profitability is analyzed intuitively nearly all the time, a competently made analysis model can give priceless advantage to the company when making important decisions and evaluating decision making (Pellinen 2006, 164). This is why Company X is interested in a ready base model to future use

when offering EPC projects. The model was built during this study and it was tested with the cost data used in the analysis. In this profitability analysis the company's margin is one meaningful input. In this case study a margin of 10% is used. Projects 1 and 1S are used in the next example (Table 9).

Table 9. Profit difference between Project 1 and Project 1S.

	Project 1	Project 1S
Purchase orders	6 098 800 €	6 073 200 €
Project execution planning	1 248 200 €	1 243 200 €
Project execution supervision	521 400 €	453 600 €
Project Joint Costs	23 700 €	33 600 €
Project Allowance		588 000 €
Project Total costs	7 900 000 €	8 400 000 €
Hour margin (10%)	176 960 €	169 680 €
Total profit	176 960 €	669 680 €
Profit %	2.24 %	7.97 %
Total difference		492 720 €

With the help of the model it could be calculated how much profit could have been gained if the project would have been made as EPC. In Table 9 it is shown that using the factors from Table 4 and assumption made on chapter 3.3 Evaluation phase the gained extra profit from Project 1S would have been nearly half million euros. In Appendix 1 it can be seen a larger table with also the rest of the projects.

It can be noticed that taking a risk to operate a project as EPC can bring an extra profit of even more than one million euros. However it has to remember that changing functions and probably tools and systems some extra costs will take place. But even the changes would cost one million euros it can be assumed that the change is profitable. That one million is gained back in probably two well executed EPC projects.

Implementing EPC model to the Company X's functions is an investment which cost would need to be calculated in the company. Costs are caused by several things, few of them are:

- personnel working hours
 - o training
 - o learning new procedures
 - o general infos
- new systems and tools
 - o consults
 - o licenses
- possible new personnel
 - o recruitment
 - o onboarding
- changes in organization

Applying the EPC model is a big change where all the company's functions need to do its share. The true price for the change might be impossible to calculate but the most relevant costs are the training hours for the personnel in project activities and procurement and possible system upgrades to implement the EPC structure to the used software. As assumed earlier even though the costs would be one million euros the investment would paid itself in two projects like Project 1S.

Also it must be taken into account the opportunity costs the investment or the decision to not invest would cost the company. One of the Company X's client has started to inquire EPC projects instead of EPCM. This client is a very important and strategic client for Company X. If Company X decides not to start operate as EPC it may lose the client completely in which case a certain share of all Company X's profit will vanish along the client.

On the other hand if Company X decides to invest to the EPC implementation the chances to keep the important client are bigger and also there is a better chance to make more profit through the EPC model.

4 EPC IMPLEMENTATION IN COMPANY X

The implementation of EPC model should be acquired as any other in-house development project. First a project organization is chosen to execute this project. The true needs would be carefully identified and the term EPC needs to be properly clarified between all the persons in the project. Step by step the changes in function in different departments are gone through and changes to process maps are made. According to these changes the changes to the used software is done with the help of an experienced consult. Not until the EPC is completely clear to all the company's functions the new functions should be deployed. More detailed impacts on company functions and simple guidelines to follow through implementation are presented in following subchapters.

4.1 Effects on company functions

The possible implementation of EPC model in Company X would effect in the whole company. The major changes would apply in the project execution functions. As seen on the calculated factors in chapter 3.2.1 the biggest percentage changes where set to project management, project control, procurement and all its sub activities. Smaller changes would apply to engineering design activities and project execution supervision.

Internally there would also be some changes at least in finance, legal and sales departments. The finance department would need to establish a team only for the project invoicing and to corporate closely with project functions especially with procurement department. Legal department would need to concentrate more to the frame agreements with contractors and suppliers. Especially in the beginning this would demand a lot of work when there is not any frame agreements. Also the new EPC contracts would require more work at the start of the implementation. In

sales they would need to learn the difference between project models and how to calculate and make offers to the new clients in a new model.

4.2 Guidelines

Company X is implementing EPC project model to its functions. It is not only about implementing a new system but a new way of working. Because EPC model is something completely new to the company it has to learn the difference between EPC and EPCM. The learning should reach to the sales, legal and finance departments in addition to project execution functions.

The learning procedure is not simple. It will continue through several EPC estimations, offers and hopefully executions. Only the learning to make a considerable offer could take a long time. And not until Company X gets its first EPC to execute the true learning will start. Because it is about a long learning procedure it requires continuing iterating between departments and functions. To achieve a good cooperation between functions there should be named persons to be responsible of the development of EPC project processes.

5 CONCLUSIONS

To Company X EPCM model is a known and reliable form of working and it sure good business also on its own. However there is a major client who changed its way of presenting its enquiries from EPCM to EPC model. If Company X doesn't start to respond to the new EPC enquiries they might lose the important client and so a lot of yearly profits.

Company X needs to investigate the possibilities of EPC model and what does this new model require. According to this study there are significant differences between EPC and EPCM models. The cost structure and finance are different and the functions would also change a bit. But probably the biggest question is the size of the risk which transfers from the client to supplier when changing from EPCM to EPC. Project business is always risky but when operating as EPC practically the whole project's risk is on the supplier. Legal knowhow is very important as also offering EPC projects. EPC projects shouldn't be offered too lightly. The scope must be clear when calculating the cost estimation and offer. The cost estimators have to be very aware of what differences the EPC brings to costs compared to EPCM.

In this study it was clear that Company X should start learning to operate EPC project to keep the important client. Well performed the EPC model might raise profit shares. Also it may provide new clientele and the chance for bigger market shares in project services. Providing EPC in addition to EPCM lifts Company X to a new niche and grows the company to a better known.

To acquire the EPC model to company's business selection an investment has to made. However the extra profits the company could gain from EPC projects are so large that the investment would be covered at least in few years. Of course the willingness to learn among the personnel is on a big role. If there is resistance

towards the new model to operate the learning curve drops which costs the company even more money.

In this study it was seen that EPC could bring bigger profits but also with bigger risk. The risk could be maintained moderate if the EPC project is done to an already familiar client from a known sector. Basically the first EPC projects should be done in a known environment and so that the project scope is similar to what have been previously executed. Considering these aspects this would be a good opportunity to learn the new project model.

Theoretically this study brings the differences of EPC and EPCM models from the supplier point of view. Project models are usually compared from the client's point of view maybe because it is supposed that the differences are clear to the suppliers. For a new or growing project services supplier this study could provide some basic knowledge of the differences of these two models.

The profitability analysis in this study was too related to the monitored projects and Company X so it cannot be said that same type of analysis would fit to other companies. However this analysis could give some ideas on how to start when a new project model might be applicable.

In this study it was noticed that a big problem even before going to EPC is the lack of estimation know how. A root cause analysis on this matter would be a good topic for a study. Other topics to continue this study could be the implementation of the new project model and also a deeper study of risk management in EPC projects.

6 SUMMARY

There were three research questions set for this study. In this chapter these questions are gone through with the answers achieved by this study.

- What are the structural differences in functions, cost models, risks and liability between EPC and EPCM?

- The answer to this question was found in chapter 2 where EPC and EPCM project models were presented followed by their differences. In functions there were not so many differences but in chapter 3 it was discovered that the weight in the functions would change if Company X would start to operate as EPC.

In cost models and financial structures there was big differences that would have to be thought over very carefully before changing from EPCM to EPC. Also risk and liability chapters showed the heavy side of the models' differences. Especially in risk and liability issues the company should have a very capable legal department to ensure continuing legal advisement from planning phase to project handover.

- What strengths/weaknesses/opportunities/threats do the models have?

- According to the earlier studied differences between the project models a SWOT analysis was made. The SWOT analysis was made keeping in mind the fact that Company X is already familiar with the EPCM project delivery but the EPC model is completely new. According to the SWOT analysis both models have their negative and positive impacts and it was seen that the combination of delivering these two project models would be feasible according to the analysis.

- What is the difference in the profitability between EPC and EPCM?

- In the chapter 3 the profitability analysis was tried to be made using available data. With the calculations made it can be concluded that EPC is more profitable when the project succeeds. But on the other hand if the project fails the loss is bigger. In the chapter 3 the calculations were made with the assumption that the project would succeed. But in reality it can be never known beforehand if a project succeeds or not. This is the same reason why calculating a project's profitability is very difficult or even impossible. However it can be said that Company X should start studying their real possibilities to start operating as EPC to hold on to the important client. Also it is a considerable moment to make the changes because it is a familiar client on which the learning will take place. Learning the new aspects of EPC model are easier to adopt when the client and working environment is already familiar.

The last research question is not directly answered but maybe the question should have originally been set better. For example, if the question would have been "Can the profitability of an EPC or EPCM project be calculated beforehand?" the direct answer would have been found. However it can be stated that all the research questions were answered in this thesis and so it could be said this study was successful. Taking into account earlier studies in this topic this study follows the same assumptions that the EPC model is more risky than EPCM model but EPCM model provides more flexibility during project execution. About the profitability between EPC and EPCM project models there are no studies which would answer this thesis' third research question directly. Maybe with a historical data broad enough it could be calculated if in some company their total profit share has grown or decreased after operating also as EPC model in addition to EPCM. But any historical data could never tell us if the next project would be profitable or not.

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Appendix 1

	Purchase orders	Project execution planning	Project execution supervision	Project Joint Costs	Project Allowance	Project Total costs	Hour margin (10%)	Difference without extra profit	EPC's extra profit	Total profit	Total difference
Project 1	77.2%	15.8%	6.6%	0.3%		100%					
	6 098 800 €	1 248 200 €	521 400 €	23 700 €		7 900 000 €	176 960 €			176 960 €	
Project 1S	72.3%	14.8%	5.4%	0.4%	7.0%	100%					
	6 073 200 €	1 243 200 €	453 600 €	33 600 €	588 000 €	8 400 000 €	169 680 €	- 7 280 €	500 000 €	669 680 €	492 720 €
Project 2	70.8%	22.7%	5.0%	0.4%		100%					
	5 026 800 €	1 611 700 €	355 000 €	28 400 €		7 100 000 €	196 670 €			196 670 €	
Project 2S	70.6%	15.3%	5.4%	0.8%	7.0%	100%					
	6 001 000 €	1 300 500 €	459 000 €	68 000 €	595 000 €	8 500 000 €	175 950 €	- 20 720 €	1 400 000 €	1 575 950 €	1 379 280 €
Project 3	69.8%	24.1%	5.4%	0.4%		100%					
	5 025 600 €	1 735 200 €	388 800 €	28 800 €		7 200 000 €	212 400 €			212 400 €	
Project 3S	67.9%	19.9%	4.5%	0.5%	7.0%	100%					
	5 703 600 €	1 671 600 €	378 000 €	42 000 €	588 000 €	8 400 000 €	204 960 €	- 7 440 €	1 200 000 €	1 404 960 €	1 192 560 €