LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
Industrial Engineering and Management
Master's Thesis

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A Project Portfolio Tool for Forecasting Small Projects Profitability

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ABSTRACT

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The case company in this study is a large industrial engineering company whose business is largely based on delivering a wide-range of engineering projects. The aim of this study is to create and develop a fairly simple Excel-based tool for the sales department. The tool's main function is to estimate and visualize the profitability of various small projects. The study also aims to find out other possible and more long-term solutions for tackling the problem in the future. The study is highly constructive and descriptive as it focuses on the development task and in the creation of a new operating model.

The developed tool focuses on estimating the profitability of the small orders of the selected project portfolio currently on the bidding-phase (prospects) and will help the case company in the monthly reporting of sales figures. The tool will analyse the profitability of a certain project by calculating its fixed and variable costs, then further the gross margin and operating profit. The bidding phase of small project is a phase that has not been covered fully by the existing tools within the case company. The project portfolio tool can be taken into use immediately within the case company and it will provide fairly accurate estimate of the profitability figures of the recently sold small projects.

TIIVISTELMÄ

Tekijä: Henri Storbacka

Aihe: Projektiportfolio työkalu pienten projektien kannattavuuden ennustamiseen

Osasto: Tuotantotalous

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Avainsanat: tilausten hallinta, tarjouslaskenta, projekti organisaatio, projektiliiketoiminta, sisäiset myyntiprosessit, projektinhallinnan tietojärjestelmät, monen projektinhallinta, tiedonlouhinta, projektin kannattavuus

Tämän tutkimuksen case-yrityksenä toimii suuri teknologia- ja suunnitteluyritys, jonka liiketoiminta perustuu pitkälti erilaisten suunnitteluprojektien toimituksiin. Tämän tutkimuksen tavoitteena on suunnitella ja luoda yksinkertainen Excel-pohjainen projektilaskentatyökalu case-yrityksen myyntiosastolle. Työkalun päätarkoituksena on arvioida ja hahmotella erilaisten pienprojektien kannattavuutta sekä muita tunnuslukuja Tutkimuksen tarkoituksena on myös tutkia muita pitemmän aikavälin ratkaisuja ongelman ratkaisuun. Tutkimus on erittäin konstruktiivinen sekä kuvaileva, koska se keskittyy kehittymishankkeeseen ja uuden toimintamallin luomiseen.

Kehitetty työkalu keskittyy estimoimaan tarjousvaiheessa olevien pienten projektien kannattavuutta valitussa projekti portfoliossa ja se auttaa case-yritystä muun muassa myynnin kuukausiraportoinnissa. Työkalu analysoi projektien kannattavuutta laskemalla ensiksi sen muuttuvat ja kiinteät kustannukset ja tämän jälkeen kannattavuuden käyttäen hyväksi katetuotto – ja täyskatteellista laskentaa. Pienten projektien tarjousvaihe oli ennen tutkimusta otettu huonosti huomioon tutkittavan yrityksen olemassa olevissa raportointi työkaluissa. Kehitetty työkalu voidaan ottaa käyttöön välittömästi case-yrityksessä ja se tarjoaa kohtuullisen tarkan arvion juuri myytyjen pienten projektien kannattavuudesta.

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After six years, four of them in Lappeenranta, one in Austria and the last one in Helsinki, my studies have eventually come to an end. I'm excited about moving into the next chapter in my life. During the last six years I have learned a lot and met many interesting people.

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From Company X, I would like to thank Antti for the enormous Excel and VBA support during the whole thesis. Without it, it would have been very difficult to implement the kind of tool I wanted. A big thank you goes also to Tuija for the guidance and support she provided during my thesis. It was interesting to work with Company X throughout this master's thesis project. The topic was challenging and I learned a lot. Thanks for making it happen!

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Picture 5. Discipline specific view. In the discipline specific sheet, the user can see the amount of hours per discipline that are in the database within the selected timeline.

Picture 6. Project Specific view (1/2). Below the headers all the projects and their information within the selected timeline are shown.

Picture 7. Project Specific view (2/2).

ABBREVIATIONS

BCT	Bid Calculation Tool
CRM	Customer Relationship Management
DBT	Discipline Backlog Tool
GM	Gross Margin
MDC	Max Direct Cost
OP	Operating Profit
POT	Project Opening Template
PPET	Project Profitability Estimation Tool
QA / QC	Quality Assurance / Quality Cost
ERP	Enterprise Resource Planning System
TCV	Total Contract Value
TIC	Total Investment Cost
EPCM	Engineering, Procurement, Construction, Management

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1 INTRODUCTION

1.1 Background

Project business is a growing business form in today's business world and especially among many engineering companies. Cost accounting and profitability calculation for different delivery projects contains a number of challenges and they should be emphasized and done carefully. There's a certain type of fidelity in the calculation of costs for a fixed-priced project. As soon as the project has been sold, the project must be delivered according to the estimated calculations. Poorly performed cost estimates can result in a delivery of an unprofitable project. Merely considering this, project business can be seen as an interesting research field.

In project business and in other business forms as well, it is important that the information and knowledge distributes evenly across all the departments within the organization. If distributed unevenly, the data and information cannot be fully exploited and it eventually can lead up to the loss of competitiveness. Also the level and details of information should be the same everywhere in the organization. With the help of different collaborative tools and data management systems it can be ensured that everyone in the organization, regardless of their position and task, is getting the same information. Obviously when the organization is experiencing rapid growth, the management of information and data becomes more difficult.

Every project is unique and project business is highly manifold depending on the organization. Project business has received growing attention in the research field during the latest years. This is mainly due to the fact that project management as a managerial paradigm has been increasing dramatically. (Kähkönen & Rannisto 2015, p. 11) There have been numerous studies related to different project environments during the last decade. The majority of project management

literature has focused on the management of individual projects. But also the more advanced research topics such as multi project management and portfolio management have been covered quite well. Especially multi project management has received growing interest during the recent years (Anavi-Isakow & Golany 2003, p. 10). However there hasn't been much research on the more in-depth topics such as project portfolio data management, project order management and inside sales processes related to project order management. Also earlier literature on engineering projects has focused more in the actual execution and construction phases, compared to engineering design phases (Chang & Chiu 2005, p. 179).

All engineering design companies measure the profitability of their projects. But usually the relationships between operational variables and financial performance are not analyzed sufficiently enough. As stated in the study by Chen et al. (2012) it is highly feasible to measure and estimate project's profitability before its execution (Chen et al. 2012, p. 400). Also according to Chang & Leu (2006) engineering design firm need to analyze the cause-effect relationship more rigorously in order to get valuable insights about their operation and performance. (Chang & Leu 2006, p. 205)

1.2 Objectives and Delimitations

The main purpose of this study is to examine and forecast the profitability of various small projects in a specific project portfolio within the case company. The selected case company for this study is a large Finnish Industrial Engineering company and it will be referred as Company X throughout the study. The project portfolio being investigated consists of large amounts of different types of small projects. Currently the overall view of these small projects and especially the profitability figures are not known accurately enough before and during the project execution.

This study's aim is to develop an Excel based tool for the selected small project portfolio for gathering and analyzing the project profitability information. One of the main goals is to improve the general knowledge of the financial figures and the profitability of the project portfolio within Company X. Profitability and general information in this case stands for the gross-margins and operating profits of the small projects and also the direct costs, project schedules and work load estimations. The Excel tool is going visualize and quickly show the current situation of the small project portfolio.

The developed Excel tool creates a data and information link between the two departments within Company X. The results of this study will also improve the monthly reporting and forecasting and will make it more accurate. One of the main objectives of this study was also to find a way to easily track the amount of projects in the bidding phase. The main research question for this study is as follows:

- How to forecast and calculate small projects profitability in advance from prospects?

Three sub-questions were also selected for supporting the main research question:

- What could be the best final solution and method in Company X for overcoming the problem in the future?
- What is the average estimated profitability level of the small projects within Company X?
- How can the results of this study be exploited within the research field?

The results of this study will make the comprehensive view of the small project business within Company X much clearer. Today the overall view and the status of the small projects are obscure within the case company. The internal process for handling these small projects is different in the case company than with medium and large projects. At the beginning of this internal process there is a lack

of data collection and reporting. As a consequence, relevant information of the projects is left unexploited before the execution phases. The project planners and project control engineers do not share information actively with the sales department during the bidding phase of the small projects.

Practically the objective of this study will be achieved by creating an Excel-tool combined with a project prospect database for the case company's sales department. The data for the tool is collected from the bidding phases of small projects and transferred into the database. The Excel tool then analyzes the data and produces information of the estimated profitability levels. The main source of data will be the separate project's cost estimates for individual projects and their work-load pricing information. The tool should be light and easily manageable and it should visualize the profitability levels of the selected projects. Goal is to find a solid and easy way to combine all the vital project pricing and cost estimate information out of the small projects. It is important that the developed tool does not create any additional workload for any personnel within the case company. On the contrary it should increase the knowledge within the company and reduce the work hours in sales department tasks related to order management and prospect estimations.

This study wants to highlight that the tool and solution developed during this study will not work as a final and long-term solution for the problem. This study can rather be seen as a pre-study for the whole problem and the tool and solutions should only be used temporarily. The key findings and the lessons learned from this study should be used as guidelines for the eventual final version of the project prospect estimation software. A long-term solution that relies on multiple Excels and Access databases should be avoided for a various reasons.

This study focuses only on the planning, design and implementation of the project profitability tool. The maintenance of the tool and further development is not part of the research scope. Also the more in-depth project profitability analysis of the collected project data is left outside of this study.

1.3 Research Methodology

This research is highly constructive as it presents a solution for a real-life business problem. As a result of this study a data collection and analysis system is developed for a specific case company. The solution is a Microsoft Excel –based project data analysis tool. Any similar tools or work methods did not exist in the case company before the study and neither any similar solution were presented in the existing literature. Both qualitative and quantitative research methods are used. The results of this study are quantitative since the results are based on many numerical values and statistics of the case company.

As the research focuses on a case company the study is empirical. However for the theoretical part in the beginning of the study some theoretical models and concepts are presented that are related to the case company's situation. These theoretical models will be evaluated and the relevance will be analysed and compared to Company X's situation. The research is descriptive, since one of the objectives of this study is to give information of unknown business activities and because the study focuses on a development task and on a creation of a new operating model. An objective mind-set is also kept in mind throughout the study. Interviews within the Company X were the main guides for the development of the project profitability tool. For the theoretical part the primary references used were mainly books and e-books, articles from scientific journals found from different databases and Master and Doctoral Theses related to this topic.

1.4 Implementation of the Research and Structure of the Study

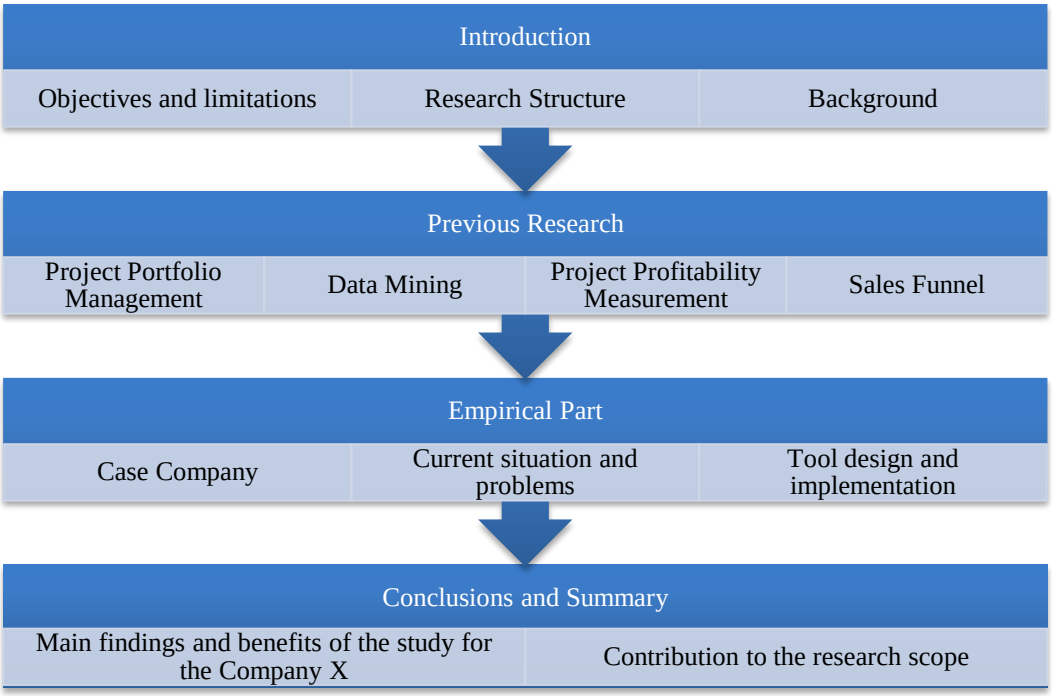


Figure 1. Study structure.

This study consists of two main parts – a theory part based on the previous research around the topic and an empirical part that will tackle the problem in the selected case organization. A simplified study structure is presented in figure 1.
First in the empirical part the present situation is explained in detail. The empirical part of this study will come from the case example. The data for the empirical part will be collected from various interviews within the company X and from Company X's internal databases and existing tools.

The data mining process by Chang & Leu (2006) will act as a main frame in the empirical part. After the case company has been presented in chapter 4, the data mining process for project portfolio tool creation will be presented phase by phase. First the objectives for the data collection process are introduced and the data needs are specified. Then the process and methods for data collection will be presented and the database will be pre-processed.

Theoretical part is a literature review of the previous research related to the topic. The theoretical part of this study has been constructed from four main theory topics: project portfolio management, data mining, project profitability measurement and sales funnel. The supporting theory frame is presented in figure 2 below. The main theory topics are examined individually, but also connecting links between them are presented.

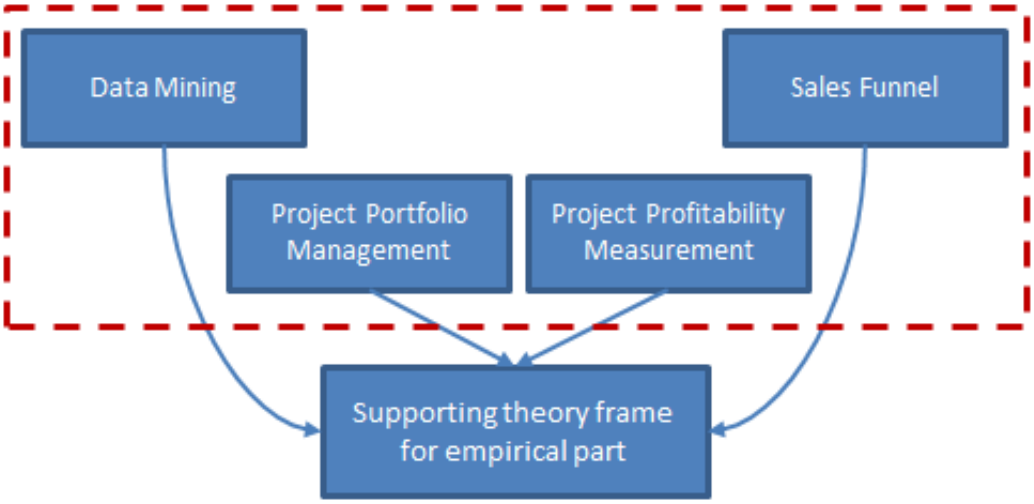


Figure 2. Supporting theory frame for empirical part.

On the basis of the research scope, literature review and empirical evidence the conclusions will be presented at the end of this study. The conclusions and findings will be then compared to the research scope and previous research related to the topic. At the end, the possibility for future research will be presented and discussed. Each chapter and their objective is analysed more specifically in the input-output diagram presented in Table 1.

The study will benefit Company X in different ways. After this study the case company will know, with among other things, the amount of small project in bidding phase and their financial figures. The tool and database created will work as a beta version for conquering this problem. In the future this study and lessons learned will work as guidelines in the creation of final bidding software.

Table 1. Input-Output Diagram.

INPUT	PROCESS	OUTPUT
Background of the research topic. Research problem in Company X.	**Chapter 1**. Introduction	Objectives and research questions. Research Problem, Methods and Structure.
Project and its importance in business	**Chapter 2**. Project Business	Delimiting and structuring the existing research regarding the research topic.
Sales Funnel. Sales Forecasting Project backlog and prospects Data Mining Project Data Management Data mining process for project environment	**Chapter 3**.Forecasting from Sales Data and Sales Funnel	What is sales funnel and what is prospects projects position in it? A model for creating a Excel tool and collecting data from Company X.
Presenting the Case Company Current Situation and Problems Existing tools and their relationships	**Chapter 4**. Case: Company X	Bringing the theoretical topics and empirical part closer to each other.
Defining data needs Creating the Project Database Analysing the profitability variables Example project calculation	**Chapter 5**. Project Profitability Tool for Sales Support	An answer to main research question: "How to forecast and calculate small projects profitability in advance from prospects?"
Objectives of the study. Research Questions and their answers.	**Chapter 6**. Results and Key Findings	Answers to sub-questions. Future research topics. Maintaining the Excel tool and future development possibilities.
Results and their reliability and significance	**Chapter 7**. Summary	Summary of the whole study.

2 PROJECT BUSINESS

2.1 Business Models in Project Business

More and more firms are organizing their business in terms of projects and this kind of business which is labeled as project-based business has become an accepted business strategy (Ajmal, Helo & Kekäle 2010, pp. 156). Project business can be defined as an industrial marketing setting in which the business is built around discontinuous, unique and complex deliveries of different projects. According to Ajmal et al. (2010) a project involves group of people working together with shared responsibilities and resources to achieve a collective mission. (Ajmal, Helo & Kekäle 2010, p. 157) Project business can be seen as the part of business that relies directly or indirectly to projects, with the purpose of achieving firm's objectives. (Artto & Kujala 2008, p. 470)

In project business there are various kinds of business models that influence in projects, companies and company networks. The business models don't necessarily have to follow the boundaries of a firm and they usually cross intra- and inter-organizational boundaries. Business models are usually seen as the link between the organization's strategy and operations. (Wikström et al. 2010, p. 839)

A project-based company or an organization does most of its work in projects and has an emphasis on the project dimension, instead of the functional dimension of its organizational structure and processes (Lindkvist 2004, p. 3). Project business differs on many ways from other types of business, mainly due to its relational context, time-limitedness, value creation, complexity, uncertainty and the limited possibility for standardization. (Wikström et al. 2010, p. 833)

Project business management consists of two primary levels – management of projects in project portfolios and management of customer relationships. Successful management of these both levels can be difficult due to the unique

qualities of the projects and customer relationships. (Mainela & Ulkuniemi 2012, pp. 103). Project business environment has also attracted considerable interest in research field during the last two decades (Mainela & Ulkuniemi 2012, pp. 103). And according to Artto & Kujala (2008) there are four major areas of research within project business:

1. Management of a project
2. Management of a project-based firm
3. Management of a project network
4. Management of a business network (Artto & Kujala 2008, p. 470)

In this study the research is focused on the management of a project-based firm and further into the management of certain project portfolios. Project portfolio management research includes a wealth of decision-oriented models for the strategy implementation with multiple projects, portfolio performance management and the difference between managing individual projects and project portfolios. Besides the management of portfolios the management of a project-based firm covers the research on three additional topics as well:

1. Project suppliers firm's ability to sell and deliver projects to its customers
2. Management of innovation
3. Project portfolios
4. Development programs (Artto & Kujala 2008, p. 472 - 478).

2.2 Multi-Project Management

There's an increasing demand for managing more and more varied and disruptive projects at different project life cycles at the same time. This poses new problems for organizations. (Dooley, Lupton & O'Sullivan 2005, p. 466) Managing multiple projects at the same time poses also challenges to the organization and often the problems associated with the management of multiple projects are more than the sum of the problems associated with individual projects. The project

portfolio management team is responsible of any individual project problems and of the challenges related to the management of the portfolio. Dooley et al. (2005) categorizes three focus points within organizations for the effective management of project portfolios:

1. Alignment management, which means the balancing of individual project objectives with overall organizational objectives.
2. Control and communication, which means for example the challenges of maintaining motivation across multiple project teams or for example maintaining optimal resource allocation across the project portfolio.
3. Learning and knowledge management, which stands for the learning from the already closed projects. (Dooley et al. 2005, p. 473)

The ever-increasing number of projects in an organization has necessitated effective management of multiple projects. This is one of the reasons there has been a lot of interest to develop processes and tools related to project portfolio management. Many tools and software's have been developed for assisting and automating processes managing multiple projects (Reyck et al. 2005, pp. 524). The management is difficult because the attention, available resources and project control tools must be spread over many projects (Pennypacker & Dye 2002, pp. 8). Often in organizations that have large multi-project environments it is difficult to obtain quick status or progress report on individual projects. Usually these organizations invest significant resources into building and maintaining project monitoring systems. (Anavi-Isakow & Golany 2003, p. 17)

Managing multiple projects can be very challenging. Projects, in a multi project environment, typically have a unique and complete life cycle with different start and finish dates (Pennypacker & Dye 2002, pp. 8). The lack of priorities, categories, standards and a large variety of tool applications complicates the startup and initiation of projects. Project based business is difficult for human resources as well, because coordinating workforce between projects is more difficult than normally. The problems are especially accelerated today because of

business time-frame demands, tight budgets and very short project deadlines. Because of this fast pace environment, an investment to an IT project usually comes later than needed (Pennypacker & Dye 2002, pp. 6)

2.3 Project Portfolio Management

Projects need to be viewed as an integrated portfolio rather than a disjointed collection (Dooley et al. 2005, p. 468). A project portfolio is a set of different projects that share and compete for scarce resources and are carried out under the sponsorship and management of a particular organization. This coordinated management of a project portfolio delivers increased benefits to the organization. (Meskendahl 2010, pp. 807)

Project portfolio management is a way for an organization to analyze and to collectively manage a group of current or proposed projects and therefore gain advantages that would not have achieved with individual project management. Same was as a financial portfolio; a project portfolio must be monitored and rebalanced at regular intervals so that the organization will get the best value out of the project investments. (LaBrosse 2010, pp. 75)

Project portfolio management is defined as the simultaneous management of a large collection of projects as an entity. This coordinated and combined portfolio activity increases benefits to the company. Many studies show the importance of project portfolio management in evaluating, prioritizing and selecting projects in line with the organization's strategy (Meskendahl 2010, pp. 807). Project portfolios can be seen as "powerful strategic weapons" since they are one of the central building blocks in strategy implementation (Shenhar et al. 2001, pp. 699)

The research around project portfolio management is quite new and the research has produces most often decision-oriented generic process models for strategy implementation with multiple projects (Artto & Kujala 2008, p. 478). Project

portfolio management requires sustained data analysis in order to gain clarity in prioritizing projects, allocating resources and tracking performance and profitability. There are many software's for the management of project portfolio, but regardless which software is chosen, it needs to be tailored for organization needs which can be demanding. Project's value need to be evaluated and tracked constantly against established criteria. (LaBrosse 2010, pp. 78)

It has been a common understanding that when an organization is managing many different project portfolios, there should be one common management approach to all of the projects. However according to Payne & Turner (1999) better results are achieved from the projects when the procedures are tailored to different projects. This means that the procedures are matched with the size and type of the project. According to their research Payne & Turner state that when an organization applies common procedures across all of its projects, regardless of the project size and type, it increases the risk of failure. (Payne & Turner 1999, p. 55)

Payne & Turner (1999) give several reasons why procedure tailoring is important depending on the project:

- When managing small and medium sized projects, the main focus is to prioritize the resources across several projects.
- However when managing larger projects, the main goal is to coordinate a complex chain of events and activities, balance the resources across these activities and to stop the bulk work becoming resource constrained. Larger projects have much greater data management needs than small projects.
- In the management of major projects however the focus is on the coordination of people across several sub-projects and on the management of risks. (Payne & Turner 1999, p. 56)

2.4 Industrial Engineering Projects

Industrial engineering is a traditional and mature industry. Industrial engineering work usually means planning, design and construction supervision for a construction project. Historically, the pricing for engineering projects and engineering services has been based on the amount of labor-hours (Sturts & Griffis 2005, p. 56). Often the requirements of owners and other stakeholders do not change dramatically and work standards are pretty much established in the industry (Chang & Chiu 2005, p. 179). Industrial engineering companies are one of the most typical companies that manage multiple projects at any given time (Geraldi 2007, p. 2). Usually the projects of larger contract have high uncertainty, but project of long duration are not necessarily the same (Chang & Chiu 2005, p. 186). The objective of an engineering consulting firm is to produce projects rapidly and with high quality. This makes the firm competent. (Mezher et al. 2005, p. 138)

Engineering consulting organizations collect various kinds of data from their operations such as cost and man-hour expenditures from their projects, but then they do not analyze this data as effectively as possible (Chang & Leu 2006, p. 199). The data analysis and the possible information obtained could help the organization to analyze project profit and productivity. However performance measurement of engineering design activities is often poorly understood. (Chang & Chiu 2005, p. 179)

During the last decades many big operators in the oil and chemical industry have reduced their involvement in project management. Also many studies have shown that engineers are accepting lower labor rates and tighter design budgets, which has reduced the profitability of the engineering industry as a whole (Sturts & Griffis 2005, p. 57). In the majority of cases the reduction is done with the help of EPCM project type, which stands for engineering, procurement and construction management. In these projects the EPCM work-load is implemented by different

engineering contractors. For example in this study the engineering contractor is Company X. The engineering contractors are involved in the project development stages as well that lead up to the final approval of a project, prior to project implementation. The relationship between the engineering contractor and the client has become increasingly important and the EPCM contract type must be an effective part of the overall project execution strategy. The project owner is usually the best placed to bear the cost risk consequences, while the engineering contractor is best placed to manage cost risk. (Berends 2000, p. 165)

According to a research by Chang and Chiu (2005) the project nature doesn't affect project or productivity. This implies that project nature is not the critical success factor for engineering work. Design projects have usually lower uncertainty than for example planning projects since the design work is more straightforward and engineers are competent in such work. (Chang & Chiu 2005, p. 186)

3 FORECASTING FROM SALES DATA AND SALES FUNNEL

3.1 Sales Process in Project Based Organization

Scientific research regarding sales has focused mainly on selection, motivation, compensation and to some extent on sales organizations. However, very little research has been conducted on the sales processes, sales management and especially on sales funnel. Additionally for example automation of sales process has become important in today's business world, but yet it has not been covered studied much (Sheth & Sharma 2008, p. 261).

According to the findings of Storbacka, Ryals, Davies & Nenonen (2009), the 21st century sales is changing rapidly. The sales are managed more and more like a process, rather than a series of separate transactions carried out by different functions within the organization. Sales process can be simply defined as the activities and actions performed by the seller when selling certain project or product. Secondly it was noted that sales are transforming from isolation to cross-functional. This means that there are increasingly close working links between sales and operations, as sales become linked with delivery. Three common changing themes in sales functions:

- from function to process
- from an isolated to a cross-functional activity
- from operational to strategic. (Storbacka et al. 2009, p. 24 - 26)

Sales process should be treated like a production process where different activities convert leads (raw materials) into closed sales (finished goods) (Cooper & Budd 2007, p. 176). The sales and project operations need to be integrated carefully. Otherwise the organization could end up contracting more work than it can deliver

satisfactorily. Sales functions should present project contracts to the organizations in sufficient quantity to avoid starving project resources with too much work. (Cooper & Budd 2007, p. 175)

When a certain project is under its planning and bidding phase, there are usually a lot of uncertainties. There might be requirements related to production resources that are uncertain, and also unknown underlying factors that affect these requirements. These overlapping uncertainties need to be observed during sales process and especially in bidding and taken into account. (Missbauer & Hauber 2006, s. 1006)

3.2 **Sales Funnel**

Sales funnel is a tool for illustrating the sequential narrowing of a field of possible customer projects (leads), to qualified opportunities (suspects), further to the best few (prospects) and finally to closed and won projects (contracted and scheduled projects) (Dalrymple 1987, p. 380). A model of the sales funnel linked to a multi-project environment is presented in Figure 3. In this figure the process of turning an individual case from the market into a project and further into a profit for the company is presented. This process narrows the sales focus by allowing only the best opportunities to pass through to the bidding pool and further into contracted and scheduled projects. (Cooper & Budd 2007, p. 175 - 176)

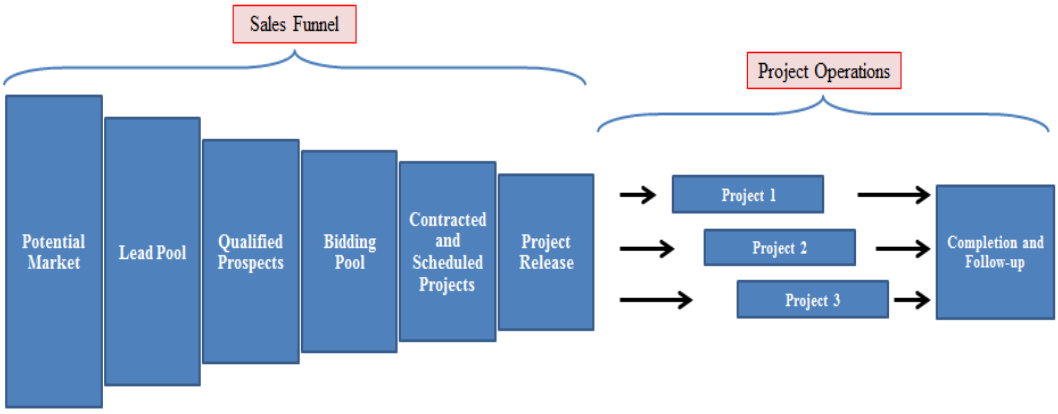


Figure 3. How the sales funnel and project operations are linked together in a project-based organization. (Cooper & Budd 2007, p. 174)

Although the sales funnel as a concept is mentioned rarely in literature, it is already a well-established term in the business world. Sales funnel is an effective way to describe the customer acquisition process witha different stages (D'haen & Van den Poel 2013, p. 5). Sales funnel is usually pictured wider at the beginning and narrower at the bottom of the process (Patterson 2007, p. 187). The goal of many industrial companies is to ensure that every phase in sales funnel is always filled with at least a few projects (Söhnchen & Albers 2010, p. 1356).

Over time and with more experience organizations become more aware of the typical number of projects required at each sales funnel stage in order to achieve a certain sales goal. Organizations should also monitor the probability of closure at each stage. Coordinating the amount of closed contracts is extremely important and should be strictly controlled since it might have a strong impact on customer satisfaction. The process ends either with the company winning the bid or losing the bid to a competing company. It is also possible that the client decides not to continue with the investment, which also results in losing the bid. Either way the experiences should be fed back to colleagues involved in earlier stages. (Cooper & Budd 2007, p 176 - 177)

Cooper & Budd (2007) suggest that the rate of closing sales contracts should be tied to the maximum rate of project production. It is believed that businesses can control and manage variability and uncertainty better internally than externally. The rate of closing sales should be subordinate to operations rather than the opposite, which is currently the norm for most forecasting models. (Cooper & Budd 2007, p. 175)

3.3 **Project Backlog**

After the bidding has been started for a certain project, a work-load is usually registered first into a backlog database as a prospect. Then later on if the bid has been won and confirmed, the prospect project is turned into a contracted and scheduled project in the same backlog database. A backlog can be defined as a list of sold projects that still need to be completed (Marchesi et al. 2007, p. 243). In other words a project backlog can be seen as the total value of unexecuted contracts that have not yet been billed (Urich & Hofferberth 2013). At the figure 3 on chapter 3.2 a project backlog stands for the projects that are on the "contracted and scheduled projects" phase. It is important for a company to visualize the work-load from the project backlog and from the upcoming prospects (Collins 2010, p. 104). Ongoing and planned projects should be kept in a project portfolio backlog. (Krebs 2009)

A study from Blichfeldt & Eskerod (2008) showed that even though organizations have adopted portfolio management practices, they still have difficulties with completing projects within the schedule and don't have a broad overview of ongoing projects (Blichfeldt & Eskerod 2008, p. 357). Project backlog can be an excellent tool for predicting organization's future success. A backlog enables professional sales organizations to put a strategy in place, which helps optimizing both project operations and future sales. (Urich & Hofferberth 2013) There are several good reasons for keeping a project backlog database:

1. By keeping a backlog an organization can reduce over- and under-loading of resources and balance the workload.
2. By observing the backlog list and its composition, it is possible to rearrange the order of the projects in the list in order to improve the overall performance of the delivery.
3. Backlog list also serves as an early warning control for the organization that manages multiple projects.
4. Also in some cases the costs associated with projects that are held in the backlog list are expected to be lower than those that are in operation. Overhead costs that are accumulated for each day a project is in operation are not charged when the project is in the backlog. (Anavi-Isakow & Golany 2003, p. 11)

Project backlog and project forecast / prospect are the two main components for the prediction of the current and future profitability of an organization. As the project backlog is the contracted work not performed, it is usually the most accurate indicator of short-term revenue. A project prospect on the other hand reflects the uncertainty the project will be put under contract. Prospect is a project that is possibly to get with a certain probability. When the project backlog and project prospects are reviewed together, it provides a very accurate picture of future revenues and workloads. (Seal 2013)

3.4 Contribution Margin Pricing and Full Cost Accounting

According to the study by Chen et al. (2012) it is highly feasible to be able to estimate project's profitability before it execution (Chen et al. 2012, p. 400) (Uusi-Rauva 1989, p. 36). The cost and revenues of the whole project life-cycle need to be viewed before project execution, in order to ensure its profitability. Controlling the costs is especially important in the project planning and design phases, because decisions made in this phase have often the biggest impact on the

total project costs. (Artto, Martinsuo & Kujala 2006, p. 150 - 151) (Kuprenas 2003, p. 25)

The most common method for categorizing costs is to divide them into fixed and variable costs. Usually the dependence of company's operating rate decides whether the cost is fixed or variable. Variable costs increase and decrease as the company's operating rate changes. Only those costs whose dependence on operating rate is extremely clear should be recognized as variable costs. The most typical variable costs are for example direct materials and hourly labor costs. In turn, fixed costs do not depend on operating rate, but rather on the changes of potential factors and capacity. Fixed costs usually increases irregularly (machine purchase or the recruitment of new staff). Other common fixed costs are for example rent, heating, electricity and IT costs. (Uusi-Rauva 1989, p. 20-21, Neilimo & Uusi-Rauva 2007, p. 56)

Cost-based project calculations can be done before and after the project execution. All products should be priced before selling and the calculations for supporting pricing are primarily preliminary calculations. This means that cost-based calculations can be exploited both in pricing and in post-inspection (Uusi-Rauva 1989, p. 36). Once the costs have been categorized, it is time for cost allocation. The two most common methods for allocating costs are contribution margin pricing and full costs pricing/accounting, which are presented in Figure 4. Contribution margin (also referred as gross margin) is calculated by subtracting the variable costs from the return of sales. The final profit (operating profit) is then obtained by subtracting the fixed costs from contribution margin (Figure 5). (Neilimo & Uusi-Rauva 2007, p. 67)

Return of Sales
- Variable Costs
= Contribution Margin
- Fixed Costs
= Profit

Figure 4. Calculating contribution margin and profit. (Neilimo & Uusi-Rauva 2007, p. 67)

Alternative for contribution margin pricing is full cost accounting, where all the company costs are allocated for the project. Another alternative for full cost accounting is activity-based costing, which is an application of full cost accounting. However activity-based costing is fairly heavy to implement and use, which is one of the main reasons why it has not received any bigger popularity in organizations. (Neilimo & Uusi-Rauva 2007, p. 116, 143)

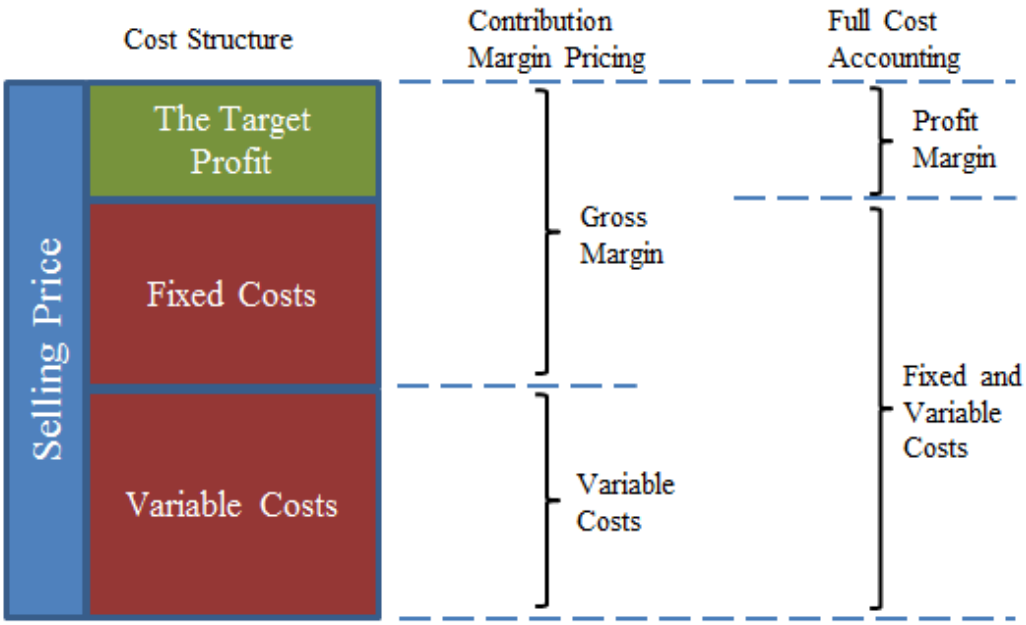


Figure 5. The two most common methods for cost allocation: contribution margin pricing and full costs accounting. (Neilimo & Uusi-Rauva 2007, p. 119)

3.5 Other Methods for Measuring Project Profitability

Many of the existing studies around the project financial performance measuring have focused on predicting cash flows to working capital and fixed capital requirements of projects. However, very limited amount of research has focused purely on profitability forecasting. (Chen et al. 2012, p. 400) Usually the most common activity in the initial project phases is to estimate the projects costs and schedule (Stamelos & Angelis 2001, p. 759). This estimation is a critical step for successful planning and controlling of projects. Especially the prediction models that focus on the early profitability estimations are important, because it enables the organization management to intervene early if needed. (Chen et al. 2012, p. 400)

Chan et al. (2012) wanted to highlight that project-initiation and planning phases affect strongly on the project's profitability and they are the fountainhead of project financial performance. Estimating project's financial performance is the key in aligning its operations with its strategic direction. (Chen et al. 2012, p. 408) Flow-type forecasting has become popular among project-based organizations during the last decades. Reliable forecasts provide the groundings for effective management of working capital, and it eventually leads to better profitability and performance (Chen 2008, p. 171)

The forecasting methods based on the standard S-curve and CSI-models (Cost-schedule integration) are great for making predictions of individual projects (Figure 6). The standard S-curve model determines the relationship between projects cumulative costs and time elapsed in percentage, and generates cumulative costs by integrating that relationship with the contract values. These predicted cumulative costs are then further converted into cost flows. S-Curve

Techniques can nowadays allow more and more detailed predictions for individual projects. Despite the more advanced technologies, the reliability is not accurate enough for company-level cost flow forecasts and their main potential are in individual project measurements. The reliability of these models weakens dramatically when making cost flow forecasts at the company-level. This is mainly because it is difficult to estimate the amount of on-going projects in future and the type of the projects. (Chen 2008, p. 171 - 172)

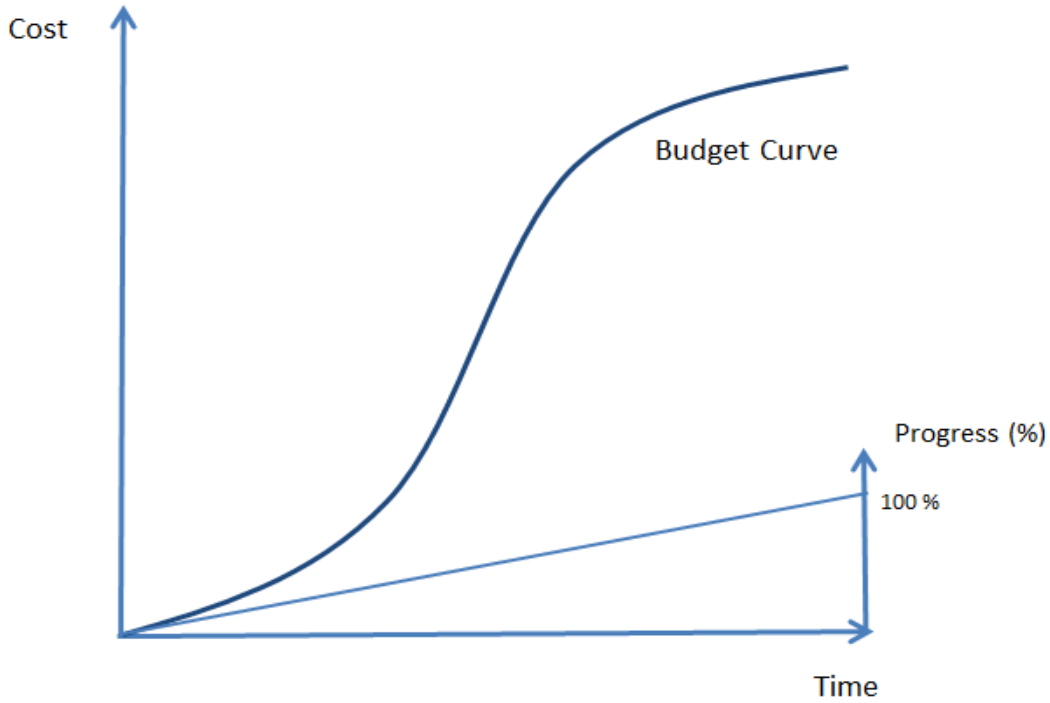


Figure 6. Integrated Cost and Progress S-Curve (Barraza et al. 2000, p. 143).

Barraza et al. (2000) developed a more advanced method of the S-curve called SS-curves (Stochastic S-curves). SS-curves are created by determining and simulating the activity level variability in cost and duration. SS-curves provide probability distributions for expected costs and duration for a given percentage of work completed. This technique automatically monitors the project performance and compares it to the most likely budget and duration values. With the SS-curve method it is possible to evaluate the actual project performance and take into

account the natural variability of project cost and duration by presenting the many possible outcomes of the execution. (Barraza et al. 2000, p. 142)

According to Chen (2008) the best organization-level cost flow predictions for project-based organizations are achieved with a combination of many different cost flow forecasting methods. This includes S-curve, CSI models, organizations internal financial values and certain macroeconomic values. (Chen 2008, p. 179)

The study by Chang & Leu (2005) presented different variables on engineering design project that affect the project profitability. Chang & Leu (2005) found out five important variables and project type related issues that affect the profitability. These following cause-effect relationships should be taken into account by engineering design companies in project planning before the execution:

1. Transportation project were found more profitable than other project types.
2. Projects that included construction supervision were more profitable than design and planning ones.
3. Projects with shorter duration are more profitable than projects with longer duration.
4. If the project included Quality Assurance and Quality Control (QA/QC) work-load, it had positive effect on project profitability.
5. Also projects that implement QA/QC were observed to have lower uncertainty and equivocality. (Chang & Leu 2005, p. 205)

3.6 From Raw Data to Information and Knowledge

When the project order requires a high degree of customization and unique engineering, it is difficult for an organization to collect, store and process the order information. Very often this is the case when the order type is engineer-to-order. In engineering-to-order environment the efficient order management is important and there’s a need for information system that support the complete order management process. (Sjøbakk & Bakås 2013, p. 262) With the help of

different information management systems today, project information can be easily stored, shared and changed. Different systems can be easily linked with each other and the data can be exploited, regardless of the data location and complexity. (Philpotts 1996, p. 11)

Especially for engineering companies explicit knowledge is more technical in nature and it can be more easily expressed and shared than tacit knowledge. Tacit knowledge is difficult to articulate but making it available throughout the organization will improve the company's performance and profitability. This knowledge can be made available by different data mining tools. Data mining means the generation of potentially useful knowledge from raw data. (Chang & Leu 2006, p. 199)

Loshin (2012) describes business intelligence as the tools, technologies and processes that are needed for tuning data into plans and decisions that drive profitable business actions (Figure 7). Further one of the most important functions of the successful management of business intelligence is to turn data into information and knowledge. This process can be described as data mining. (Loshin 2012, p. 7)

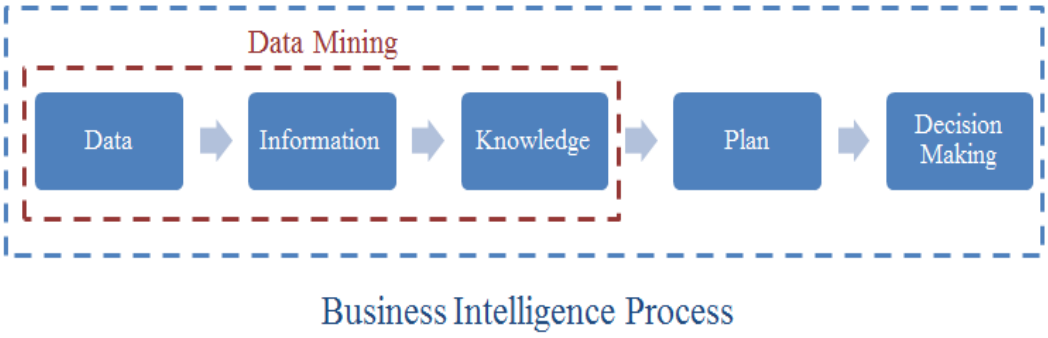


Figure 7. From business data to decision making. (Loshin 2012, p. 7)

The amount of data organizations collect from their business has seen explosive growth during the past decade. The objective of data mining is to find non-exploited relationships or previously unknown potentially useful patterns from

business data and to allow businesses to make predictions of it for future use. Chang et al. (2006) simply defines data mining as the process of generating potentially useful knowledge from raw data (Chang & Leu 2006, p. 199). If the hidden information can be made explicit, it can be used in improving business processes (Feelders, Daniels & Holsheimer 2000, p. 271). Data mining has emerged as a key business intelligence technology. Larose (2014) described data mining as the process of discovering useful patterns and trends in large data sets (Larose 2014). (Lew & Mauch 2006, p. 5-6)

3.7 Data Mining Process for Project Environment

When studying 548 projects in an engineering consulting company Chang & Leu (2006) divided the data mining process into six different steps. The six stages are illustrated in Figure 8. The three first steps are for preparing the data and the last three steps are for analyzing and interpreting it. This process is very similar to a data mining process, but it has been modified to fit a project environment. (Chang & Leu 2006, p. 200)

In the implementation framework Chang & Leu (2006) categorized different variables to three groups: input variables, process variables and output variables. Chang & Leu then analyzes the variables between the groups which helps to identify the variables affecting project profitability. Example variables for output are profitability and productivity. Variables measuring process can be for example quality assurance and costs, budget and man-hours. Lastly input variables can be for example project type, duration and contract amount. (Chang & Leu 2006, p. 200)

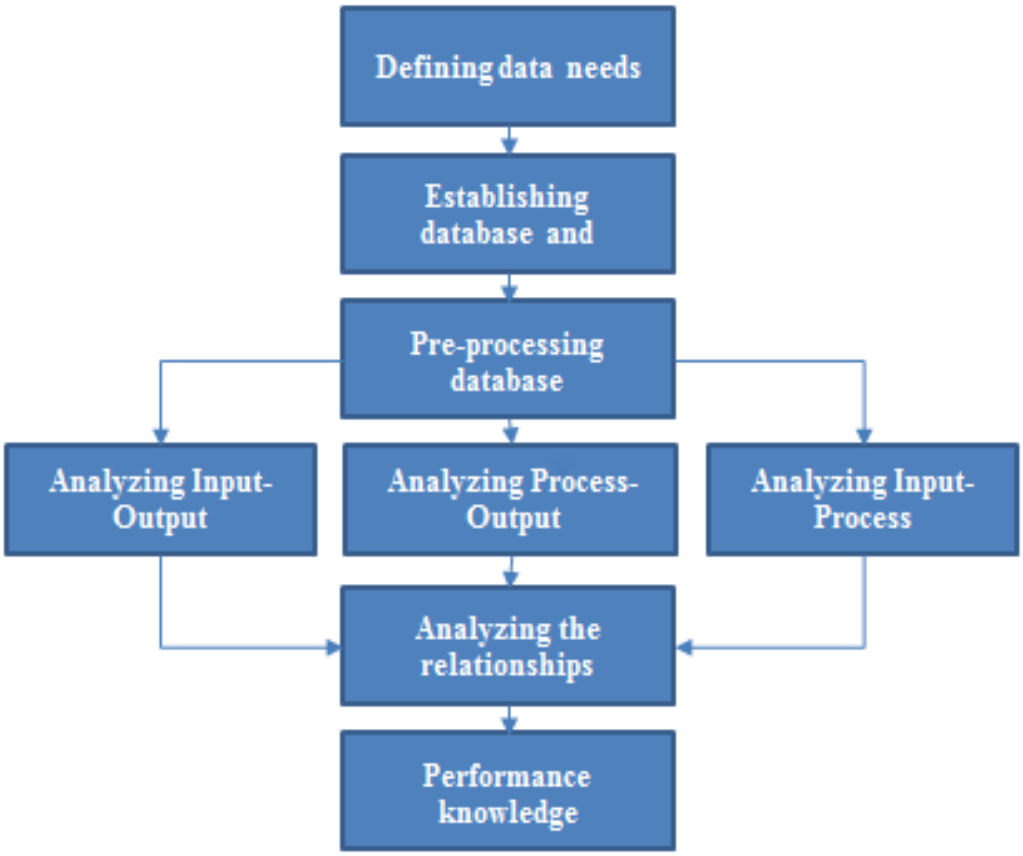


Figure 8. Data mining implementation (Chang & Leu 2006, p. 201).

An organization gains valuable performance and profitability knowledge from the completion of the data mining implementation process. The last step in the process is to manage the new knowledge and transfer it to the right persons within the organization. After the implementation process has finished the organization must ensure that the obtained information is utilized in the most effective way. (Chang & Leu 2006, p 201)

Sumathi & Sivanandam (2006) presented an alternative view of the data mining process and highlights that the data mining process continues after the solution has been deployed. Their model consists of four stages (Figure 9)

1. Data Selection
2. Data Transformation

3. Data Mining
4. Result Interpretation. (Sumathi & Sivanandam 2006, p. 197-198)

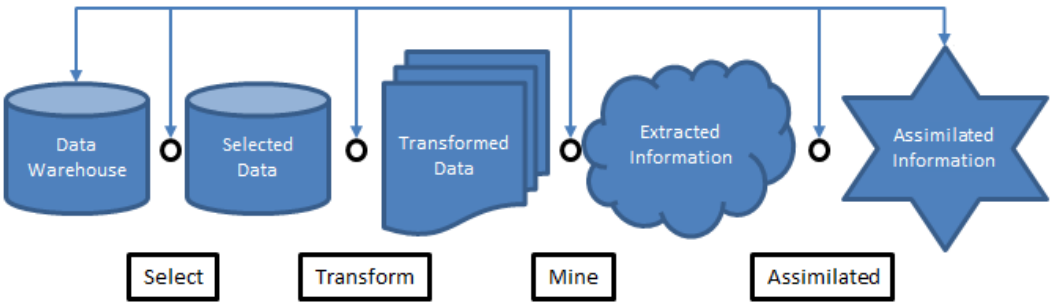


Figure 9. The Data Mining Process. (Sumathi & Sivanandam 2006, p. 197)

In the first step of the model the user needs to select the desired database tables and identify the data to be mined. After that in phase two the user usually needs to transform the data so that it is easier to read and analyze. According to Feelders et al. (2000) the data selection and transformation phase are the most time-consuming activities in the data mining process (Feelders et al. 2000, p. 280). This phase can range from converting the data to applying mathematical operators. In this model the third step (Data Mining) stands for the extracting of desired type of information. In the last step the user has to analyze the mined information and the organization should make corrective actions based on the new information if needed. (Sumathi & Sivanandam 2006, p. 198)

Sumathi & Sivanandam also highlight that the actual mining plays only a small role in the overall process. The data selection and planning are important and time-comsuming and also if the user for example selects inappropriate data and the result might suffer. In this case the process should be started again. Secondly, the data mining process is not completely and it involves a variety of feedback loops. This means for example that the data can be re-selected if needed and data mining phase can be rerun. Thirdly, visualization plays an important role in the various steps. Statistical visualizations such as scatter plots and histograms are highly recommended. (Sumathi & Sivanandam 2006, p 199)

4 CASE: COMPANY X

4.1 Overview of the Company X

The case company selected for this study is a large Finnish industrial engineering company and it will be referred as Company X throughout this study. Company X operates in a mature engineering industry, where the requirements of the stakeholders usually do not change dramatically. Also the work standards are pretty much established within Company X, which is in line with the previous research regarding the industry (Chang & Chiu 2005, p. 188).

Company X sells various kinds of engineering services. The engineering services sold are Company X's products where it gets its revenue from. During the last few years there has happened a rapid expansion and internationalization and Company X has also set foot on few other countries. Company X has many years of experience from engineering new plants worldwide.

Company X has moved more and more towards providing fixed price contracts for its customers, which in turn enables a better profitability when exploiting the know-how and actions from previous projects. However on the other hand when working with fixed-price contracts, it is more important to deliver within the estimates done for the project. The client is only interested in what they have bought; they are not interested in the amount of work that has been done for it.

4.2 Sales Organization and Portfolios

The sales organization of Company X uses a process-driven business model in its operations. Company X has aimed not to localize the sales process. At its best the process doesn't take place just at the sales department and various persons from different departments should participate in the sales process. Company X operates with a process-based business model where it is critical not to localize activities

into a one department (Figure 10). For a project based organization it is important to link sales and delivery processes closely together as seen in Chapter 3.2 (Cooper & Budd 2007, p. 174). For example the project and sales department should interact with each other and share information actively.

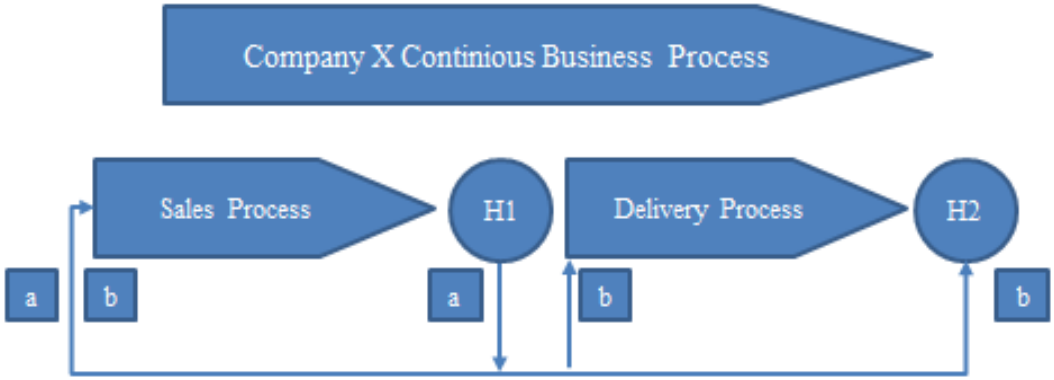


Figure 10. Company X Continuous Business Process.

- H1 = Handover from Sales to Delivery; project opening and work planning, follow-up and implementation
- H2 = Return Handover from Delivery to Sales; back to sales for project closing and detail Performance Data with KPI's
- a = Initial Reference Data for use in further sales and development
- b = Final Reference and detail Performance Data with KPI's for use in further Sales and development of efficiency in Delivery

More specifically Company X's has divided its sales process before the handover from sales to delivery into five different phases:

1. Uncover Needs
    - Uncovering and influencing on customer's needs
2. Prepare Solution
    - Building Company X solution
    - Align Company X team around the sales project and evaluate customer needs for fit against Company X solution

3. Present Solution
    - Create the persuasive customer proposal and summarize customer benefits
4. Negotiate
    - Agreeing terms and conditions
    - Prepare and plan for the negotiation
    - Summarize and confirm the deal or no deal
5. Secure & Learn
    - Handover to the execution
    - Communicate case outcome and document win/loss reasons
    - Assuring the delivery and collect reference data
    - Lessons learned

4.3 Company X's Project Phases and Processes

Company X has divided its client's project work processes into seven different phases. The different phases are illustrated in figure 11. This study and the Excel-tool developed will only collect and analyze the data from the small projects that are feasibility studies, basic engineering studies or execution phase projects. These three project types create and represent a significant portion of the annual work-load and revenue among small projects. In the future and after this study all project phases should be taken into account in profitability calculations and sales forecasts.

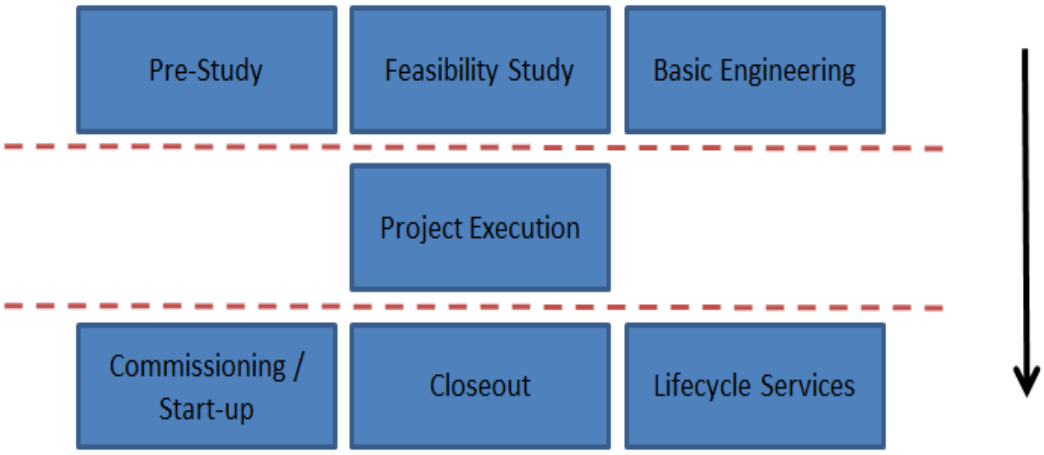


Figure 11. Company X Client Project Processes.

The objective of a pre-study is to evaluate the opportunities of a project. In this phase the most suitable project execution alternatives are chosen and a rough project cost estimate is prepared, which's accuracy of the total project's costs is + / - 40 %. Basically, the objective is to determine whether there is a basis for further investigations and whether the opportunity can be turned into an actual project.

During the feasibility study the objective is to identify the main project approaches, analyze different concepts, select the technology and to prepare a more accurate cost estimate (+ / - 25 % accurate estimate on the project's total costs) than in the pre-study phase, in order to confirm project's viability. The cost estimates for the basic engineering and execution phase are done during the feasibility study. Also the documentation for the basic engineering phase will be prepared.

During the basic engineering phase the cost estimate accuracy will be + / - 10 % for the grass root plants and + / - 15 % for the modifications of the existing plants. Also the design basis of all disciplines will be finalized. During this phase a more detailed and accurate cost estimate for Execution phase is performed.

Project execution can be further divided into 4 phases: Project management, detail engineering, procurement and construction / pre-commissioning hand over. The objective of this phase is to manage, coordinate, execute and report engineering, procurement, construction and pre-commissioning activities according to the objectives set up in the project plan.

After the project has been executed the objective of the commissioning and start-up phase is to perform the operating activities required to achieve the design performance levels. The purpose of the closeout phase is to obtain the final acceptance certificate and to close the project in an orderly fashion. Company X also offers various kinds of lifecycle services after the project completion, which can include for example maintenance and future developments.

4.4 Project and Sales Process Tools within Company X

There are various different tools that support the sales functions and project operations within Company X. Majority of these tools are Excel-based and they contain macros. The relationships and connections between the different tools and systems is quite complex as different types of projects go through the sales process tools the different way. In this chapter the sales process tools related to this study are presented in detail.

Discipline Backlog Tool

The delivery organisation and human resources within Company X uses a Discipline Backlog Tool (DBT) that has been created with Microsoft Access and Excel. The DBT tool shows the current backlog of projects (confirmed projects) and also the projects that are in the bidding phase (probability to happen over 50 %). The DBT-tool gathers the information from the current open projects from ERP -system, from the projects created with BCT-tool and also CRM that are currently on bidding phase (project prospects).

Currently DBT lacks key information of various small projects which usually contains different types of maintenance work or repairs for the Company X's biggest customer. Since the small projects are not being processed in the BCT-tool, there is no current prospect database for the small projects. The small projects are nonetheless added to the DBT-tool as backlog projects after the project has been opened to ERP-system. However, the small projects represent a significant portion of the work-load on a yearly basis. Keeping this in mind it would be critical to get the DBT to register these orders already as prospects.

Bid Calculation Tool

Bid Calculation Tool (BCT) is an important internal Microsoft Excel -based tool for calculating and estimating bid costs and prices within Company X. It was originally developed to Company X sales environment during a Master's Thesis project. It has grown into a very complicated, versatile and highly used tool within the sales organization.

The biggest issue regarding the use of BCT is that the small frame orders and small projects are not managed there in any way, and therefore they are not registered into prospect database in DBT. Currently the process would be too time-consuming for small orders and considered unprofitable. The BCT process is very heavy and detailed, which is why it has only been used for large orders and projects. If the small orders would be processed with BCT there might be a possibility that the sales process would demand more work hours than the actual project.

Project opening template

Project opening template (POT) is an Excel file that contains all the main information of the project. POT contains the project start and end date, cost estimate and the amount of EPCM hours. POT- template is filled for every project that has been won and it contains the clients and Company X's signature.

Cognos

IBM Cognos Business Intelligence solutions are widely in use within Company X and its ICT and sales departments. The data related to cost prices for different disciplines regarding this study is obtained from the IBM Cognos databases.

Project Cost Estimate

Project cost estimates are Excel-files that are done individually done for each project. Every small project, regardless of it being feasibility, basic or execution phase project is planned and calculated with the project cost estimate Excel – template. The Excel contains all the pricing and work-load details of a small project, but it doesn't include any information of the project schedule. The Excel-file has been protected and it can even be sent to the client for further inspection if needed.

A gate review meeting is held for all orders for the purpose of reviewing the project cost estimate. In this meeting the portfolio manager, project controller and project manager selected for the project will discuss the detail of the order with the help of the project cost estimate. The participants go through at least the project cost estimation summary and the grounds of the cost estimation, which is a Word-file containing all the explanations for different figures and values in cost estimate. All the reasons and arguments for the Excel calculations and estimates can be found here.

Project cost estimate is calculated by Excel, where the detailed project cost information can be found. For example the amount of hours is estimated by disciplines, all the material costs are listed and also the possible client and vendor costs. This cost estimation has been done by project engineers and the purpose of the gate review meeting is to get the portfolio and project manager's approval for the calculation.

4.5 Current Situation and Problems Related to the Study

A simplified version of the small project order process is presented in figure 12. The dotted line from the small project prospect tool to Discipline Backlog Tool means that the connection should be done in the future, after this study. With the help of this study a connection from the project cost estimates is made to the sales department for profitability analysis.

The small project process begins from a work order that has been requested and issued by the client. In this work request the client defines the project needs and whether the work is for example design or execution. Company X then begins the design the project work and prepares an estimate of the project costs and also a proposal for the price of technology work, which stands for the total contract value for Company X. During the estimation and proposal phase Company X changes information with the client. If after reviewing all the proposals, the client decides to choose Company X's proposal, the bid will be won and a project opening template can be filled. With the help of POT template the work order will be registered into the ERP system and automatically to DBT.

With the help of this study, a new prospect database for project estimates is established. This new database stores all the small project bid information from the bidding stage. This data is then later moved into PPET (a project profitability estimation tool), where it will be transferred into profitability information.

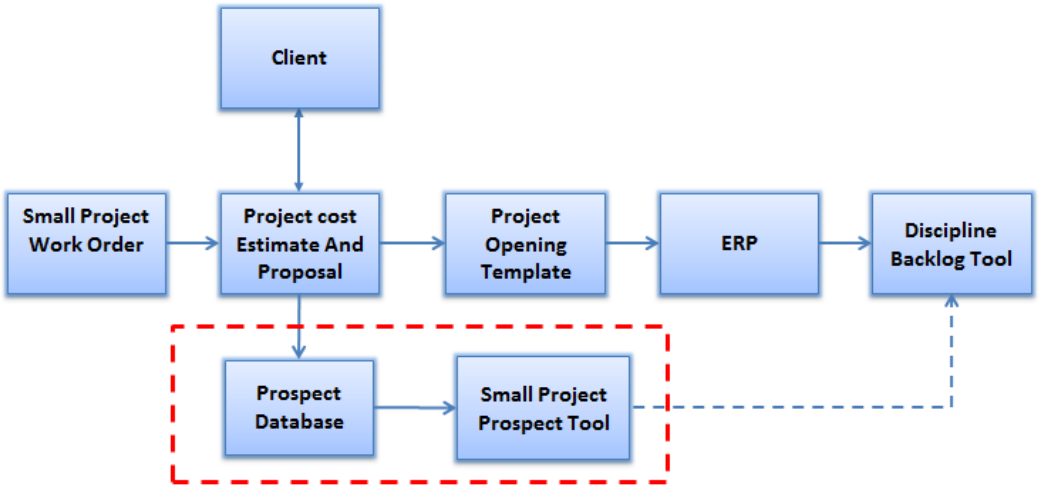


Figure 12. How the small project order management will change.

Company X maintains a project prospect database in DBT for the medium and large orders. A prospect project is created when a certain project or a work-order is possible to get. Overall within Company X, a project possibility is registered as a project prospect when the probability of the project turning into an actual project is considered to be over 50 %.

Main problems considering the small project portfolio:

1. No prospects of the future projects, only a backlog of the confirmed projects.
2. No clear or easily obtainable financial or profitability estimations of the prospects and sold projects.
3. The working process for the small project bids differs from the working process for other bids, which causes problems
4. Overall view and the status of the recently sold small projects is unclear within Company X.

In the small project cases the prospect project has a slightly different meaning. Usually the small projects are done within various frame agreements that Company X has with some of its main clients. In this case a frame agreement is a seasonal agreement between the client and supplier, where the hourly rates of

delivered work are agreed for a certain time period. Within this frame agreement the clients order many projects from Company X annually. These frame orders are usually different types of maintenance work-orders or design and management services. Basically a frame-work project that's on the bidding phase can be assumed as a case that has been won. The rare cases that don't turn into an actual project happen because the client decides not to continue with the investment.

As soon as the client has requested the project work from Company X and the cost estimate Excel has been done, the POT –form (Project Opening Template) will be filled by project engineers with the project information. The project cost estimate Excel is an estimate of the client's project costs or TIC (Total Investment Cost). A portion of these costs are company X work for the project. This work is a combination of project engineering services and project engineering management services that the company X does for the client in the project. This proportion is in the key focus in this study and pricing information remains unexploited in the sales department, even though the proportion accumulates the company X's prospects. Company X would like to find out the value of these small order prospects and their estimated profitability with the help of this study.

Large frame orders and projects with other customers are managed differently in the sales process within Company X. Company X has determined a certain price level for an individual project frame-agreement that decides how the bid review will be carried out. Bigger projects require more personnel for the bid inspecting and approval than small projects.

Depending on the urgency of the project and various other reasons, it can take anywhere from 1 day up to 4 weeks before the project engineers receive the signed POT's and cost estimates back. In other words it can take weeks from the client's proposal before a small project is opened to ERP-system and it appears to the DBT. The current backlog and forecasting tool DBT only registers the projects that have been opened to ERP or projects that have been done with the BCT (Bid Calculation Tool). Due to the large amount of small projects every year, the BCT

process is too time-consuming for small projects. The untracked area in the beginning of the sales process is where Company X sales department would like to receive information from. Currently the backlog and prospect data is not complete and it is missing important information from various small orders.

The most important data used in DBT-tool is project- and discipline-specific schedule information. DBT-tool needs discipline specific dates for each project. In order to create a sales funnel for Company X, DBT-tool needs to know for example when automation work hours will be executed in the project and how many hours there will be in total. If the above mentioned data is not provided it is not possible to add the project to DBT database.

For medium and large projects the sales department does most of the cost estimation and pricing with the BCT tool. In this cost calculation the sales department calculates the cost of work per hours for company X and then adds the profit to it. The result is the selling price for the client. For the small projects the project team does the project cost estimate themselves, which includes the sales prices of the company X's work for the project. However the profitability calculation is missing from this calculation step and the cost of work per hours for company X is not calculated. Basically the work for small project is done in opposite direction when compared to medium and large projects, where the desired profitability level is first decided and the sales price based on that.

The small projects that are in question in this study present quite large percentage of the yearly projects for Company X. Individually these small projects are small considering Company X's size and due to the large number of these orders per year the same order-handling method is not suitable. Handling all of the small projects in BCT has been experienced too time-consuming and unprofitable. Small projects have been handled differently in sales department where the audit and pricing operations are usually performed. Due to this, it is difficult to get any accurate hours per discipline estimations to ERP -system. The small projects represent approximately 10 - 15 % of the yearly turnover and work-load for

Company X. There's usually between 600 - 800 small projects annually and they in total produce over 150 000 work-hours for Company X.

Despite the large number of projects every year, the handling and backlogging of the small projects is done differently than with other projects. The process is not as informative as with other projects, since the prospect hours are not updated to the sales organisations databases and the prospect information is not available for inspection. Especially the Company X's sales organisation needs the vital information from small projects. Also the profitability tracking of the recently sold small projects is missing. The accurate sales figures and profitability estimates are necessary and vital in sales departments monthly reporting.

4.6 Company X Sales Funnel

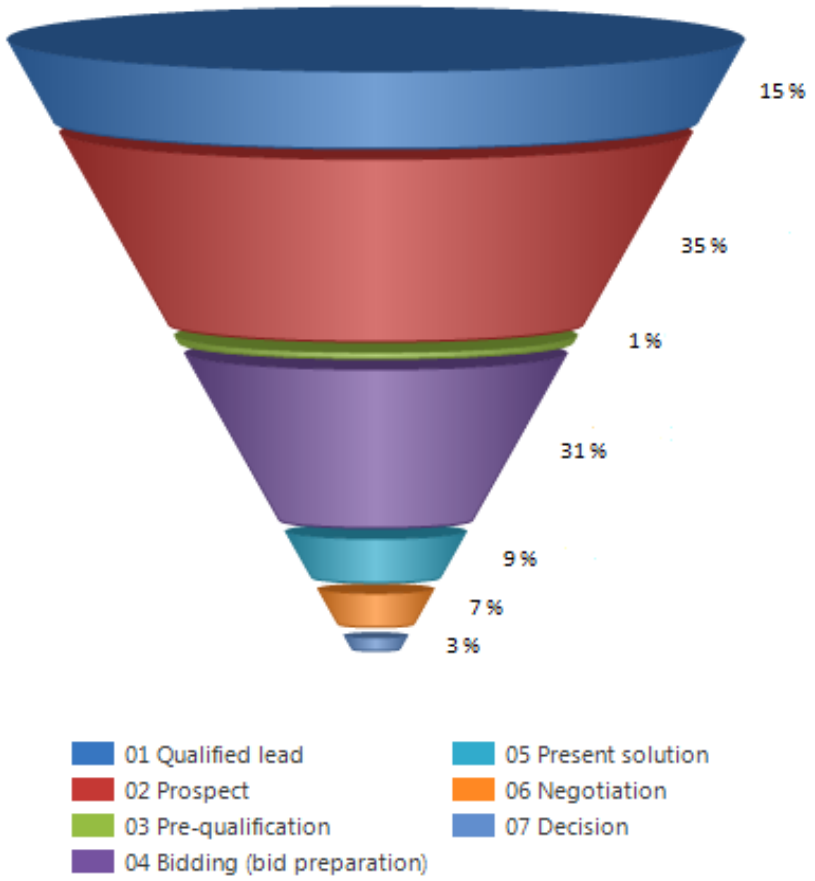


Figure 13. Company X sales funnel as of June 2015.

Company X manages and monitors its prospect, sold and on-going projects with a quite similar sales funnel as presented in literature (Chapter 3). The sales funnel is presented in figure 13. The sales funnel is managed and held in the CRM – system. All of the Company X's project opportunities, regardless of it being confirmed or in negotiation phase, are registered in the sales funnel. Both the shape and the funnel phases are similar to the one presented in literature. Company X's sales funnel consists of 7 different phases and the largest amount of projects are usually located in prospect and bidding phases. These two categories, when combined, are usually over half of the Company X's total sales funnel value.

5 PROJECT PROFITABILITY ESTIMATION TOOL FOR SALES SUPPORT

5.1 PPET Background

There's a need for a real-time project database within Company X that shows all the recently sold projects and their estimated financial figures. A project prospect database is being kept in CRM for all the other projects, but not for a large number of small projects due to their different nature. It is important for the sales organization to know and predict the profitability of projects immediately during the projects planning and bidding phases. Currently the small project profitability figures are not easily available.

In this chapter the operating principles of the developed Excel-tool will be explained in detail. The designed small project profitability estimation tool will be referred as PPET (Project Profitability Estimation Tool) in this study. Since almost all of the needed information for this study is located in different Excel-files the project prospect calculation tool will also be designed and created with Microsoft Excel. PPET will be viewed and presented with a few pictures in appendix 4.

Microsoft Excel is widely used within the Company X and it is a fairly light and easily manageable tool for performing spreadsheet calculations. Making beta-versions of different tools and software's with Microsoft Excel is cost-effective and not very time-consuming. Excel can also be easily linked to databases, to other Excels or even to other programs and software's with macros and the help of VBA (Visual Basic for Applications) programming language. For the creating process of the PPET, the framework of Chang & Leu (2006) that was presented in chapter 4 will be used as a guideline for the building process. The framework will be modified slightly in order to fit Company X's current situation more specifically.

5.2 Defining data needs

There are four main sources of information that the PPET will need for functioning properly:

1. Individual project cost estimate excels
2. IBM Cognos – Company X's own work cost information
3. ERP system – Additional project information
4. Primavera – Project scheduling information

The main data collected for the PPET tool will come from the project cost-estimate Excels. The project and information variables needed for the profitability calculation of the small projects are the following:

- Project Code
- Disciplines / Activities needed in the project
- Discipline-specific hours planned for the project execution
- Discipline-specific hourly rate
- Estimated project start date
- Estimated project end date
- If the project is a basic design phase project, the project code of feasibility study phase is needed.

All of the above mentioned variables are currently obtainable from the cost estimate Excel, expect the estimated project start and end date. Because the scheduling is done with a different program called Primavera Scheduling software, there are no date variables in the cost estimates. At the cost estimating phase the project planners don't input the dates anywhere to the cost-estimate Excels and neither is there a place for date input.

In order to properly find out the amount of prospect projects and their profitability for the next months, the project schedule information is vital. For addressing this problem the cost estimate Excels were modified and a small field for inputting the project start and end dates were added. The date variables could also have been collected from Primavera, but in order to facilitate the VBA coding it was determined to include the date variables to the cost estimates.

5.3 The Project Data Collecting Procedure

In order to get the desired results for this study an extra worksheet was added to the cost-estimate excel file for the purpose of data gathering. This tab called "AccessSummary" was then programmed with spreadsheet functions to collect data automatically, that was presented in chapter 5.2. After that, a connection from the project cost estimate Excel was made to the Microsoft Access –database with Excel VBA editor using macros. The Access –database will work as the project data storage between the project cost estimates and PPET. The process of collecting the project information from the various project cost estimates to the Access-database is visualized in figure 14 below.

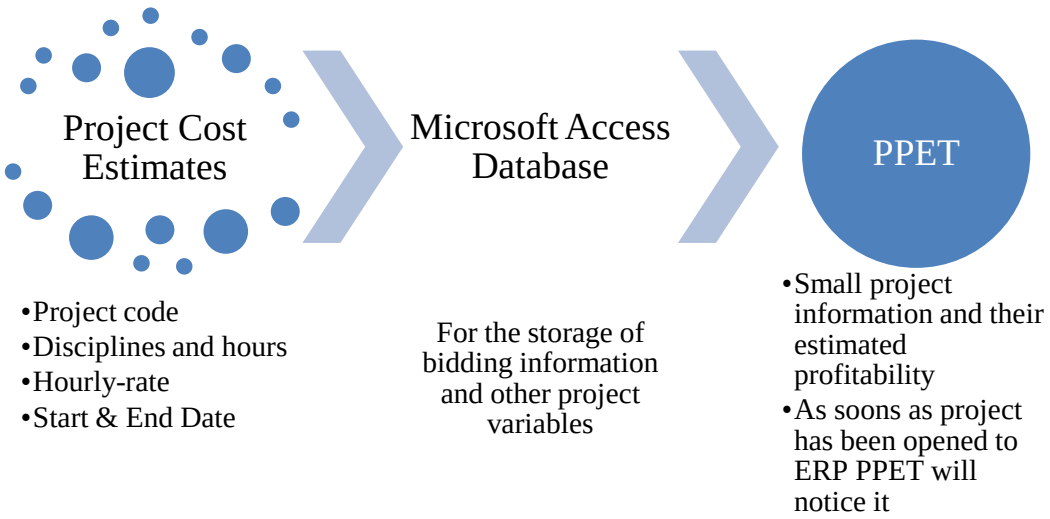


Figure 14. The process of collecting project cost estimate data into Access-database and further into PPET.

The VBA -code was kept as simple as possible. The code's main principle is to go through every discipline presented and check if the hours planned for that discipline is greater than zero. If there is planned hours for a certain discipline, the information is send to the Access -database. Of course if the planned hours for a certain discipline are zero, the code will not execute and the code goes on to the next discipline.

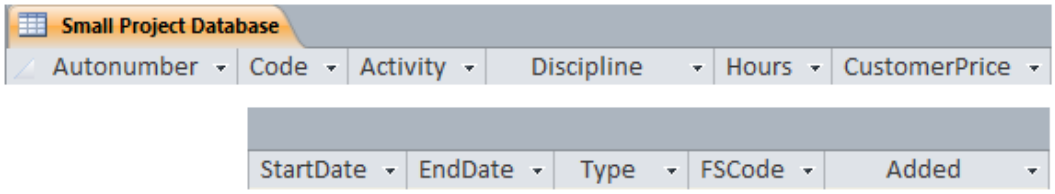
A few simple error checking procedures were also added for ensuring a smooth and bug-free performance. Firstly the Excel – user is in control whether the project prospect information is sent to the database or not. By keeping the functionality user-controller, it could be ensured that the database would not fill up with unnecessary information. Secondly, if the user decides to send project information to the database, the code will first check if all the necessary project information has been given. This means that the user will be prompted with error messages, if for example the project code field is empty or project start date is later than end date. These error checking procedures were simple, but necessary. By keeping the incomplete data away from the databases, the prospect calculation is simpler and the data is more reliable. The data should be ready to use as it is in the database, any extra handling and modification would be too time-consuming and not efficient in the long-run.

During the modification of the Excel-template the underlying idea was to not cause any additional work-load for the project engineers and planners. Intention was to make the data collecting procedure as unnoticeable as possible, so that it would not affect to the current work process at all. Also another objective was to make the data collection as simple as possible, both on the appearance and code-wise. The goal was to make a tool that would be easy to modify, maintain and understand even by an external person. This facilitates any possible error-correction in the future if the small project work-process would change for some reason. Also the goal was to ensure that PPET will maintain its functionality even if some of the key persons developing it will leave the organization.

Company X's own work cost data will be transferred into the Excel-Tool where the data mining itself will take place.

5.4 Establishing the Microsoft Access Database for Project Data

Microsoft Excel alone is not powerful enough for handling and storing information from multiple sources and it suits poorly for functioning as a database. Because of this more powerful database software called Microsoft Access was used as the database for project information. The Access –database collects and stores data from the cost-estimate Excel files. It was estimated that the project data collection procedure could generate up to 25 000 rows of information every year. Considering the large amount of data, Microsoft Access will manage the data more effectively and more securely than Excel. The Access database consists of 10 different fields as seen in Picture 15 below. The fields are same as the project variables presented in chapter 6.2 and additionally there's an automatically generated timestamp field.



Picture 1. The fields in the Microsoft Access database.

The Access -database registers only small projects of the project portfolio examined in this study. Small projects that are on bidding stage are not on Company X's ERP system, since the project is not opened to the ERP -system until the bid has been won. When the small project data is being extracted from the database the Excel tool will automatically compare the projects in the database with the projects in ERP. In other words PPET recognizes automatically the recently sold projects that are not yet in the database and thus not in the coverage

of the exiting sales process tools. If the project already exists in ERP the PPET will identify it.

It is possible that in the small project estimation phase the hours already transferred to database will stay there, even if the project is not realized. This means that the client has decided not to continue with the project and has cancelled the previously planned investment. In these cases the project code and its details would remain in the database. This would eventually lead up to a situation where the prevailing small project prospect database estimate would be bigger than it is in reality. In order to avoid the above described problems the database will be programmed to automatically go through the database on a weekly basis and remove the over 12 months old project codes. 12 months is a long period, but in some cases the project can be in an inactive state for many months before eventually being executed. By this way it can be ensured that the prospect data is reliable enough for the Excel-tool to analyze it. The period of 12 months was chosen as the best alternative by the project engineers and project controllers. There were a few examples of projects that had been in the cost estimation and sign up phase for over a year.

5.5 Calculating the Discipline-Specific Cost of Labor

In order to calculate the projects profitability the discipline-specific base and full cost of labor is needed. There discipline-specific cost levels were not known within Company X before this study and they had to be calculated separately. The discipline-specific cost of labor for the small project portfolio was calculated according to the cost data received from Company X's IBM Cognos software. Order to figure out the average costs per discipline of the provided work in small projects, some calculations and assumptions had to be made.

The average base cost and full cost per each discipline costs were calculated from the employee cost-price list that covers the whole organization. An example of the

employee list is presented with made-up values in Appendix 2. Company X has multiple offices worldwide and since all of the small projects in focus are executed in the same location, first the employee information of other offices was sorted out. The calculation steps for retrieving the discipline-specific costs out of employee cost-price list went as follows:

1. Sort the employees by the office
2. Sort the employees by discipline
3. Calculation the average costs by discipline

After all the data has been collected and sorted into the database, the data will be extracted to PPET. The data will be extracted according to the selected date in PPET which has been defined by the user. The user can select the start and end date for the database search and automatically receive the small project information, including net sales and the different profitability figures calculated both discipline- and project-specific within the given timeline with the base and full cost information from Cognos.

5.6 Profitability Calculation Process

A lot of assumptions had to be done in order to get the database and PPET to function properly. These assumptions lower the quality and reliability of the profitability calculation. Most of the small projects examined in this study are projects under various frame-work agreements which are typically EPCM projects. EPCM project (Engineering, Procurement and Construction Management) stands for a project where the client selects the engineering contractor for the project, who then manages the whole project on behalf of the client. Regarding the small projects Company X usually manages all the technology work and project planning.

For these framework agreements the total investment cost (TIC) does not equal to total contract value (TCV). TCV value is approximately 20 % of the TIC value on

the projects that Company X provides, based on the data of completed projects. On the figure 15 below the "Provided Services by Company X is the TCV value for Company X.

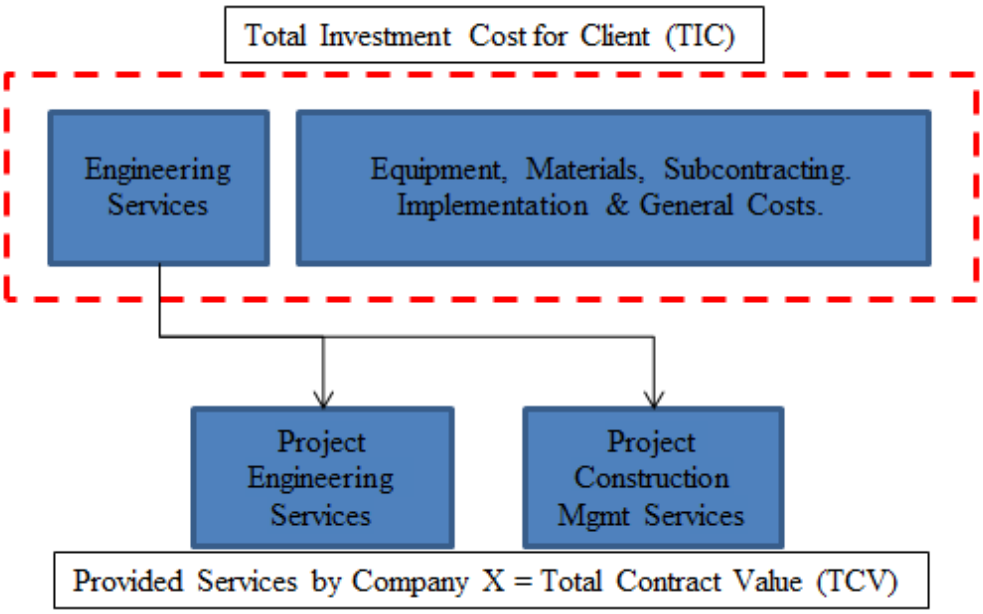


Figure 15. The portion of the Company X's services of the total project costs.

There are altogether 24 different disciplines that Company X can provide for its customers. There are 13 different project engineering disciplines and 11 different project construction management disciplines. Each discipline is priced differently compared to others and also the base costs for each discipline is different. When calculating the fixed costs (full cost) per discipline the quality and assurance costs are the same regardless of the discipline.

By multiplying the amount hours per discipline required in the project with the discipline-specific hourly rate for every discipline and then summing the results together we get the total amount of revenue cumulated from the project for Company. The obtained result still needs to be multiplied with an additional 2,5 % (or by 1,025) which is the amount of miscellaneous engineering costs for a project. The calculation procedure is presented in Figure 16. The "Total Sales"

variable represents the total amount of revenue that Company X obtains from the project and it is calculated as followed:

(1): $Total\ Sales\ (€) = Hours\ per\ discipline * Hourly\ rate\ \left(\frac{€}{h}\right) * 1{,}025$

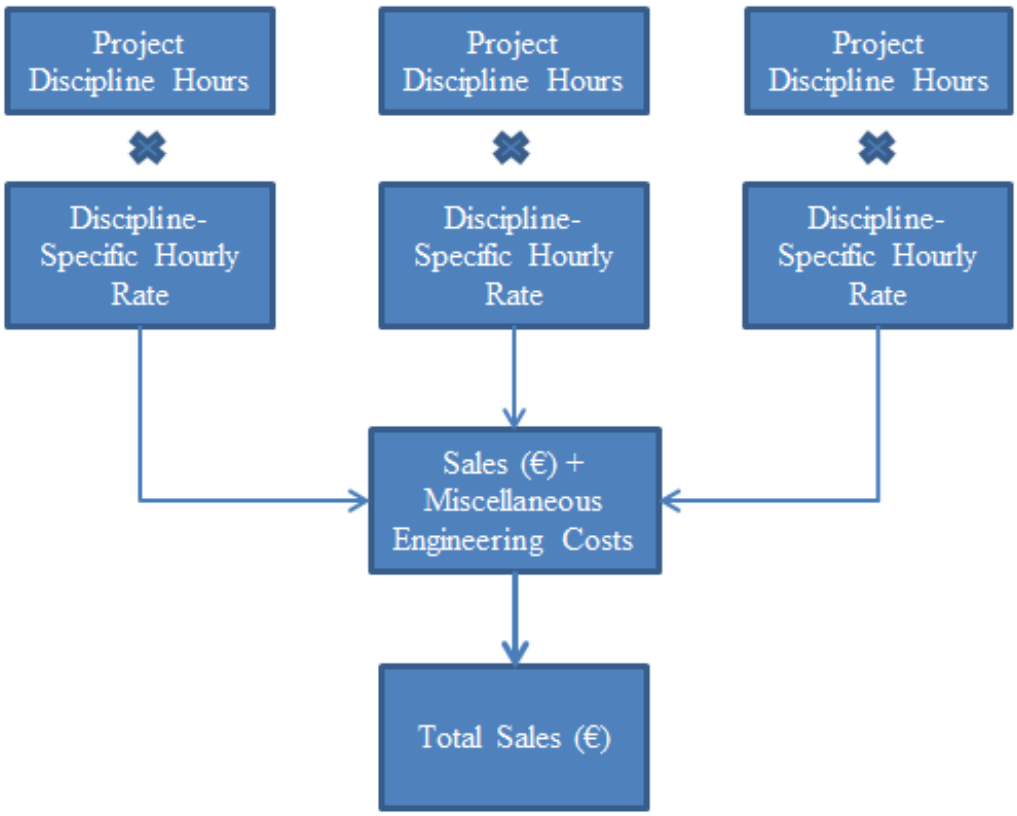


Figure 16. Formation of the total revenue for a single project.

The profitability calculation for small projects within the Company X is quite similar as for other projects as well. The calculation is simpler than for other projects since not that many variables and types of costs are needed to be considered. All of the framework agreements that are taken into account in this study are executed and performed in the same industrial location where Company X operates. For this reason there's no need for extra travel costs for example and neither need they to be considered in the profitability calculation.

The profitability of a certain project in PPET will be demonstrated with the help of the terms Gross Margin (GM) and Operating Profit (OP). OP can also be referred as 'Margin over Allocated Costs'. GM and OP are the most common ways to measure profitability for a project within Company X. In addition to GM and OP the profitability will be also represented as profit ratio (%). Profit ratio is calculated in the following way.

(2):

$$Profit\ Ratio\ (\%) = \frac{Project\ Total\ Sales - Project\ Full\ Costs}{Project\ Full\ Costs} = \frac{Project\ Total\ Sales}{Project\ Full\ Costs} - 1$$

For the calculation of OP and GM the costs of the provided work and also organizational costs are needed. The cost types needed are direct costs, Q & A costs and full costs. Direct costs for this case are calculated as followed:

(3): $Direct\ Costs\ = Base\ Costs + Agency + Equipment + Others$

Base cost is a term within Company X for describing the direct labor costs (salaries). Direct labor costs can be seen as the cost of those people who provide services directly to customer. Agency costs stands for the costs of provided work by different Company X offices. There are rarely agency costs in framework agreements. Also there aren't usually any equipment costs in framework agreements since the client is purchasing all the equipment for the project investment, Company X just estimates the equipment costs. As soon as the direct costs are known for the project, GM can be calculated. GM is simply the result of subtracting the direct costs from the total revenue:

(4): $Gross\ Margin\ (GM) = \ Total\ Sales\ - Direct\ Costs$

Naturally the direct costs are not the only type of costs that should be taken into account when calculating profitability. There are various fixed costs within the organization that should be considered also when pricing the project. Company X

has information and communications technology related costs (ICT), administration costs and other costs. These costs form the Q & A costs.

(5): $Q\ \&\ A\ Costs = General\ Costs + Administrative\ Costs + ICT\ Costs + Others$

Operating profit takes into account all of the costs related to the project and to the organization. Full costs that are needed for the calculation of operating profit are calculated by summing the direct and Q & A Costs together:

(6): $Full\ Costs = Direct\ Costs + Q\ \&\ A\ Costs$

Lastly after calculating all the different costs, operating profit can be calculated. Operating profit (also called as margin over allocated costs) can be expressed in several ways (below). Perhaps the most common way is to present it by subtracting full costs from total sales:

(7): $Operating\ Profit\ (OP) = Total\ Sales - Full\ Costs$

(8): $Operating\ Profit\ (OP) = Gross\ Margin\ (GM) - Q\ \&\ A\ Costs$

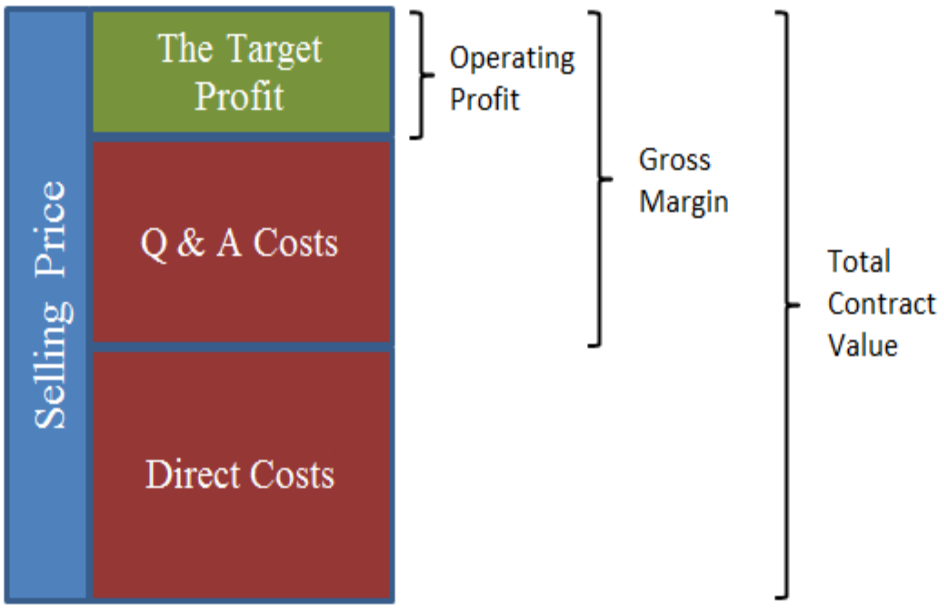


Figure 17. The relationship between operating profit, gross margin and total contract value.

The relationships between the OP, GM and TCV are presented in figure 17. The profitability calculations done for Company X are quite well in line with the calculations presented from literature in chapter 3. Direct costs represent a bigger portion of the total projects than Q & A costs regardless of the disciplines used in the project. By knowing the total contract value, gross margin and operating profit the sales department gets a simple and clear view of the project and the information can be easily transferred to monthly reports and estimates.

An example project profitability calculation is attached in Appendix 3 that has been calculated with the methods presented as in the previous chapter. The values and their relation are not genuine and they are not based on any actual Company X's project. However, the made-up values provide a reasonably accurate and instructive example of the calculation process and it visualizes the calculation steps effectively.

5.7 Analyzing the Estimated Profitability Variables

The last step in the data mining process presented by Sumathi & Sivanandam (2006) in Chapter 4.2 is to analyze the new knowledge produced by the data mining process. And also according to Chang & Leu (2006) the last step in the data mining framework for project environment is to analyze the benefits of the whole process to the organization. After PPET has been developed and implemented into use for Company X, it starts to product information and knowledge, from where the actual benefits can be collected.

In this study, cost-based project-specific calculation is done before the project execution, but it can be exploited also after project has started or the project has been completed. When done before project execution the main objective is to help pricing and bidding activities. While done after completion the calculations apply well for the review of realized costs. Cost-based calculation is a simple way to examine whether the selling price of the project exceeds the project costs. By taking into account all costs within the whole organization we can also study the profitability on the organization-level.

PPET was meant to be kept simple and easily functioning tool. The tool simply collects the project discipline data from the Access-database and it then analyzes and converts the data into more readable form. The PPET tool views the current small project prospects sorted out by discipline and by project.

6 CONCLUSIONS

An organization that business is built around different and unique deliveries of projects is doing project business. And as there are many projects to manage at the same time, the organization needs to manage its data and information more effectively. According to the research the engineering companies do collect data from their project business, but they do not analyze this data as actively as it would be recommended. Same work methods do not work for every project portfolios. Because of the different project types, sizes and lengths there is a need for individually tailored tools for managing different portfolios.

A powerful way to view the current status of the on-going project bids, contracted projects and on-going projects is to view them in a sales funnel. Sales funnel needs to be viewed together with a detailed project backlog and software that shows the on-going projects (for example ERP). Successful management of these tools within the organization can give the management vital early warning signals of it business.

Linking sales functions and project operations is critical for project-based organizations success. Sales needs to be well aware of the amount of projects on every phase of the sales funnel. The probability for the bid to be won need to be calculated for every step in the sales funnel. By measuring the probability and the amount of project on the entire funnel, the sales department can accurately estimate work-hours and cash-flow in the future. Every stage in the sales funnel is contingent upon the successful execution of the previous stage.

The project profitability's were calculated by using the contribution margin and full cost accounting methods. These methods were presented in the existing literature regarding project profitability measurement as the most common ones. With the help of forecasting the project profitability the non- profitable small

projects can be identified immediately and corrective actions can be performed if needed.

The main goal of this study was to find a simple and easy way to estimate the profitability of the recently sold small projects within Company X. Also one the main goal was to find a way for Company X to identify those small projects quickly and easily that aren't yet in the ERP-system. The benefits of this study for Company X are shown on figure 18 below.

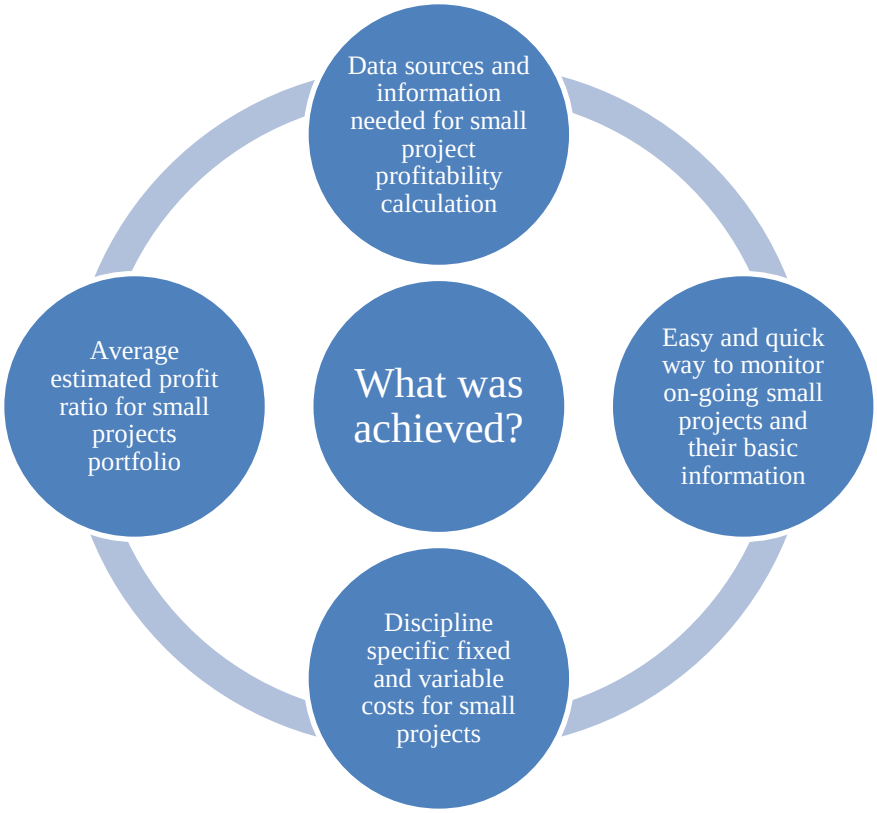


Figure 18. How the PPET helped the sales organization and what was achieved in this study.

With the help of this study Company X received an estimated profitability ratio for a small project portfolio. The ratio provided by PPET was close to the value that was previously estimated within Company X, which both strengthens the reliability of this study's calculation procedures and also confirms Company X's

personnel's previous assumptions on average profitability estimations. PPET helps the sales organization in monthly reporting, where it is often needed to report all the recently sold projects and their estimated profitability's.

The PPET increases knowledge within the Company X and reduces work hours in sales department, especially in tasks related to order management and profitability estimations of prospect projects. After this study also the data sources and information needed for small project profitability calculation are known and they can be used when the PPET functionality will be moved to ERP system for example. PPET gives Company X a fast and a quick way to view the status of the small project portfolio. Average profit ratio will be automatically calculated for small projects before actual project execution. It strengths are fully automated calculation procedure, easy maintenance and transparency.

Small projects and those performed under frame orders should be processed separately with a specifically designed process. The small projects are different in many ways compared to the large projects within Company X. For example the gross margins are lower, project durations are shorter and the projects do not usually demand as much resources. Also, when considering the different nature of frame-orders it is highly feasible for Company X to handle the small project orders differently than the large project orders.

Before the PPET was implemented to Company X, other departments could make bids to small work-orders without it being tracked or notified in sales organizations tools. Only after the small project had been won, signed and registered into ERP –system it went to DBT, from where it could be tracked. However, even though the small project was registered into DBT and ERP the profitability was not known and needed to be calculated separately.

Two of the biggest problems with having multiple tools and software's for the same process is the maintenance and the possible manually performed functions between them. As soon as the process and tools get more complicated the

maintenance becomes more difficult. If the process relies on individual macro codes and some problems arise, the code editing and fixing might be time-consuming. Also the more complicated the macros are the more skilled workforce is needed for coding, possibly even a new recruitment for solely coding tasks. The order and project handling process should be as automatic as possible. But the more automatic the process is the more logic and coding needs to support and maintain it, which in turn increases the need for coding specialists. Considering all this, it might be good to invest on specially designed software for handling sales orders, backlogging and estimations.

Company X maintains its ERP system mainly based on its own work processes and this should be the objective always, regardless of the client or the project. Despite this being the objective, the ERP –process for handling frame-work projects differs from the process of other projects. Activity structure should be the same for all of its clients. Company X should have one fixed and unchangeable list of its activities that are available for selling. This particular activity list would not change, regardless of the project phase, client or project type. The fixed list would make the project data easier to handle, ERP system easier to maintain and project calculations more simple.

It is important to keep in mind that the solution presented on this study is not the best solution for tackling a problem like this in a long-term. Maintaining Excel- and Access- files and the linked connections between the files can be time-consuming and probability for bugs and errors is big. However, the solution presented on this study can be only seen as a temporary solution for the problem. As of now the ERP system for the case company is being updated and the new ERP-system should be in use during autumn 2015. This study can be seen as a temporary beta version for the actual same functionality in ERP. By testing the work procedures first with a light and low-cost solution, the process for building the installment for ERP will be more effective and quicker. Also by knowing the possible problems and critical issues already before doing the final version, the investment cost for ERP will be eventually lower.

Based on the research and study findings it would be necessary to develop a separate bidding tool for the case company. In the future PPET should not be an Excel based tool and it should be developed by another company that specializes on tool and program development if possible. Considering the problems that the BCT was experiencing it was important to not make any similar mistakes with this Excel –project. The tools and their relationships were tried to be kept as simple and transparent as possible. This in turn facilitates the correction of arising problems and also makes it easier to connect PPET to other tools or software's within Company X.

6.1 Future Actions within Company X

Currently PPET was designed and will be used during the bidding stage for the project profitability evaluation. The discipline-specific base and full costs that were calculated in this study could however be exploited for other purposes as well. The cost information could be for example inputted into the cost-estimate Excels, so that the profitability figures could be analyzed and known already few stages before than today.

In the long-term, Company X should focus on abandoning the majority of Excel- and Access-based applications. Company X should on the contrary invest on the development of specially designed software's and programs that would perform the same functions more securely and with less manual labor.

In the future the main goal for Company X is to transfer the presented functionality from this study into the new ERP system. It would be beneficial to combine all the possible project calculation procedures under the same tool or software. The creation of the ERP functionality will be much clearer because of this study, since all the project data variables have been located and the functionality has been tested with a simple Excel-version. Also important benefit

is that the most common errors and problems are already known and some lessons have been learned.

Company X discipline-specific base costs and full costs should be updated and re-calculated at least twice a year. This way it can be ensured that the profitability estimations are as accurate as possible. Also if Company X experiences some major organizational changes or co-operation negotiations, the re-calculation should be performed more often than twice a year.

After verifying that the data collecting process and PPET works properly and after the major bugs have been fixed it is important to combine the project prospect functionality from PPET to the DBT. It is important to have a clear and combined view of the prospect and backlog project that can be seen easily with no extra calculation efforts. Also the backlog (DBT) could be further developed and it should be equipped with the possibility to see the profitability and revenue of the backlogged projects.

PPET can be used for monitoring the costs during the project execution and also as an assisting tool for project post-calculations. PPET includes the project profitability estimates that can be compared to closed projects values. There should be a link between the project post-processing calculations and PPET profitability estimates before execution. There’s a good opportunity to make PPET more accurate if the realized and already finished projects and their profitability’s will be compared with the PPET estimate.

In order to successfully operate the PPET needs planned maintenance after this study. The most critical maintenance task is the calculation and update of the discipline-specific base and full costs in every 3 months. The base and full cost need to be as accurate as possible, in order to make the profitability estimation reliable. It is also important to compare the realized projects profitability with the estimated profitability’s and investigate the possible differences between them. By

knowing PPET's forecasting accuracy its using potentials could be mapped more detail.

6.2 Possible Reliability and Validity Assessment

The interviews held during this study were executed in a semi-structured way, which left room for free discussion. Interviews weren't the main focus in this study, since the research focused on the creation of different calculation procedures. Interviews helped however to define calculation steps and also to view different exceptions within the small projects that should be taken into account when calculating prospects profitability. The developed project portfolio tool can be taken into use immediately within the case company and it will provide fairly accurate estimate on the profitability figures of the recently sold small projects.

6.3 Future Research

As a lot of time and planning went into designing the PPET, its quite minor details and its functionality, the study left a lot of interesting subjects untouched. These subjects would be interesting for future research, especially from theoretical point of view. One interesting term which is linked closely to sales process is sales funnel, which regardless of its importance in the planning and controlling project operations has remained relatively less studied within the research field. Especially sales funnels relationship to successful project resource management, and further into project profitability has not been covered on the existing literature. When sales funnel and profitability analysis would be linked closely together, it could turn the sales funnel into a "profit funnel" as well, which in turn could provide interesting profitability information to the stakeholders and management. Linking sales funnel's project stage probability information with profitability information could be a powerful tool for forecasting company's future success.

The research on project profitability is quite limited, which also affected this study quite a lot. Not a lot of research has been conducted on project profitability analysis and estimation or sales processes in project organizations, which considering at least from the author's experience is surprising. As more and more business is being done with the help of projects, it is strange that project profitability is not a more popular term within the research field. In the end the profit margin of a project should be the main concern of a company that wants to turn profit.

There's not a lot of different ways to measure project profitability and usually they are quite all-around methods. Due to this the project profitability measurement implementation process and practices presented in this study can be utilized widely within other engineering companies and companies that do project business. The study can help especially other companies within the engineering field that are struggling with the project profitability estimations or that are using frame-agreements. An existing project information database and automatic project profitability analysis should be self-evident for all companies doing project business.

PPET gives Company X a great possibility to study the nature of the small project portfolio and to analyze the profitability variables. As this study focused mainly on the design and implementation phases of the PPET, there are many interesting research and analyzing opportunities coming up during its use. At least the following questions that remained unanswered were brought to the discussion:

- What is the average amount of projects in the database?
- What is the average size of the prospects database?
- What is the relationship of the prospect database size compared to other projects on bidding phase and on sales funnel?
- What is the average time for a project to complete the bidding phase and move to ERP?

- Are construction supervision projects more profitable than design and planning ones?
- Is the effect of QA/QC on project profitability positive?
- Are shorter projects more profitable than projects with longer duration?
- Should Company X pay extra attention to projects that have longer duration?

7 SUMMARY

The case company in this study was a large Finnish engineering consulting company. The main objective was to develop and create a simple small project profitability estimation tool (PPET) that would collect and analyze all the recently sold small projects and then estimate their profitability. The profitability of a project was measured by calculating its gross margin (GM) and operating profit (OP). Gross margin was calculated by finding out the base costs (variable costs) of a project and the operating profit by finding out the full cost (fixed and variable costs) of a project. PPET visualizes and displays the overall situation of the small projects and also betters the general knowledge of the small projects within Company X's sales department. PPET was not intended to be final solution for this problem with small projects but rather, a cheap and few resources demanding beta version. The lessons learned from this study and the implementation phase can be exploited with the final solution.

The methods and procedures for handling projects and their information should be as similar as possible between different project types. This reduces the need for extra customization within the tools and procedures, and it also brings the project data closer to the end-user which helps in the analyzing process. For Company X the procedures and tools for different kind of projects are differ from each other, which causes problems in maintaining overall view of the project business.

As a result PPET should provide picture a fairly accurate picture of the small projects profitability. In the most extreme cases the unprofitable projects can be detected beforehand. The estimated profitability figures should be compared with the data of completed projects at regular intervals, in order to get an estimate of the accuracy.

The implementation procedure for the project portfolio tool can be utilized also generally outside of this study. However the calculation methods and project

variables are company-specific and they should not be used elsewhere as shown in this study.

The profitability calculation procedures and methods presented in this study can be exploited widely also in other research topics outside of this study. The contribution margin and full cost accounting methods are fairly straightforward calculation procedures and they suit well for various kinds of situations. The used model is suitable for companies that are engaged in project business and determine their bid prices by man-hours with small tailored changes.

Due to this study Company X can receive new data and information of its small project business, which would have otherwise been left unexploited. The amount of data collecting possibilities businesses have nowadays is almost unlimited and the companies that actively collect and exploit the data can obtain huge advantages compared to their competitors.

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Appendix 1. Timetable and the Topics of the Main Interviews and Meetings.

16.1.2015 Duration 1h

Attendees: Account Manager, Sales Support Manager, Project Control Manager, Portfolio Manager

Topics:

- How to transfer order information into sales systems efficiently?
- Problems with the current backlog tool and database
- How the prospects should be calculated for small projects?
- What are the ERP actions for small projects?
- The amount of small projects annually and estimated revenue?

22.1.2015 Duration 1h

Attendees: Project Control Manager

Topics:

- Project cost estimate Excels and their administration. Who are the key persons regarding the development of the Excel template?
- How the project cost estimates can be modified in order to achieve sales objectives regarding this study?
- Demonstrating and illustrating example projects within the small project portfolio

6.2.2015 Duration 1h

Attendees: Project Manager, Sales Support Manager

Topics:

- How the project cost estimates are filled?
- How many people within Company X fill project cost estimates?

- How the project cost estimates can be modified in order to achieve sales objectives regarding this study?

6.3.2015 Duration: 1,5h

Attendees: Sales Support Manager, Senior Project Assistant, Excel Consultant

Topics:

- Designing the small project prospect tool (PPET) and how should it be constructed?
- Designing the database and choosing the project variables needed for the PPET calculation

27.4.2015 Duration 1h

Attendees: Project Control Manager and Head of Project Control

Topics:

- Presenting the idea of project data collecting, the first sketch of the project cost estimate changes and macro code
- Discussing the details of different projects types and how they could be taken into account in data collecting.

5.5.2015 & 11.5.2015 Duration 2h

Attendees: Associate, Excel Consultant, Sales Support Manager

Topics:

- Presenting the beta version of the PPET and receiving comments and first thoughts
- Proposals for changes for the beta versions
- Implementing the proposed changes and presenting the corrected version in the second meeting.

- Schedule for launching the PPET and planning the necessary actions regarding the launch

Appendix 2. Calculation of base and full costs for project disciplines

This calculation procedure of the base and full costs for each project discipline is a simplified version of the real-life calculation and it has been done with made-up values. The objective of this example is to illustrate how the discipline-specific costs very calculate and estimated.

Table 2. Person specific base and full cost.

Name	Discipline	Office	Base Cost [€ / h]	Full Cost [€ / h]
Person A	Project Management	Finland	32	52
Person B	Procurement	Finland	28	48
Person C	Construction Management	Sweden	29	49
Person D	Project Management	Finland	35	55
Person E	Project Control	Finland	32	52
Person F	Project Management	Sweden	37	57
Person G	Construction Management	Finland	30	50
Person H	Procurement	Finland	28	48

Small projects that were in question in this study are executed in Finland, therefore person working elsewhere were sorted out from the list. After this the base and full cost can be easily calculated for project management for example by summing all the base costs together and then dividing the sum by the amount of persons in that discipline:

(9): $Project\ Management\ Base\ Costs = \frac{32\frac{€}{h}+35\frac{€}{h}}{2} = 33{,}5\ €/h$

And the full cost for project management:

(10): $Project\ Management\ Full\ Cost = \frac{52\frac{€}{h}+\ 55\frac{€}{h}}{2} = 53{,}5\ €/h$

Appendix 3. Example Project Profitability Calculation.

This specific project profitability calculation has been calculated with made-up values and they do not describe Company X's financial figures or costs in any way. However, the made-up values provide a reasonably accurate and instructive example of the calculation process. The calculation is performed in 7 steps (shown below).

Table 3. Made-up information of an example project.

Discipline	**Hours [h]**	**Price [€]**	**Base Cost [€/h]**	**Q & A Cost [€/h]**
Project Management	500	91	35	20
Project Control	600	90	35	20
Process Engineering	40	89	35	20
Process Technology	-	78	34	20
Automation Technology	80	87	34	20
Electrical Engineering	-	75	34	20
Instrumentation Engineering	320	85	32	20
Layout and Piping Engineering	-	84	32	20
Civil and Structural Engineering	-	79	32	20
Steel Structural Engineering	-	82	31	20
HSE Engineering (e.g. Hazop)	540	81	34	20
Automation Engineering	-	80	34	20
Equipment Engineering	-	79	34	20
Procurement	320	78	34	20
Materials and equipment procurement	-	78	34	20
Puchase of services and contracts	-	78	29	20
Delivery control and inspection	-	78	29	20
Process Field Supervision	80	78	29	20
Electrical Field Supervision	-	70	29	20
Instrumentation Field Supervision	-	70	34	20
Piping Field Supervision	-	78	34	20
Civil, Structural Field Supervision	400	78	34	20
Steel Field Supervision	-	78	33	20
Construction Mgmt	90	78	33	20

HSE Field Supervision	90	78	33	20
Warehouse	90	78	33	20

(11):

$$Total\ Sales\ (€) = Hours\ per\ discipline * Hourly\ rate\ \left(\frac{€}{h}\right) * 1{,}025\ \%$$

$$Total\ Sales\ (€) = 500h * 91\frac{€}{h} + 600h * 90\frac{€}{h} + \cdots + 90h * 78\frac{€}{h} = 264\ 420\ €$$

(12):

$$Direct\ Costs\ = Base\ Costs + Agency + Equipment + Others$$

$$Base\ Costs = 500h * 35\frac{€}{h} + 600h * \frac{35€}{h} + \cdots + 90h * \frac{33€}{h} = 106\ 930\ €$$

(13):

$$Q\ \&\ A\ Costs = General\ Costs + Administrative\ Costs + ICT\ Costs + Others$$

$$Q\ \&\ A\ costs = 20\frac{€}{h} * (500h + 600h + \cdots + 90h) = 63\ 000\ €$$

(14):

$$Full\ Costs = Direct\ Costs + Q\ \&\ A\ Costs$$

$$Full\ Costs = 106\ 930\ € + 63\ 000\ € = 169\ 930\ €$$

(15):

$$Gross\ Margin\ (GM) = \ Total\ Sales\ - Direct\ Costs$$

$$Gross\ Margin\ (GM) = 264\ 420\ € - 106\ 930\ € = 157\ 490\ €$$

(16):

$$Operating\ Profit\ (OP) = Total\ Sales - Full\ Costs$$

$$Operating\ Profit = 264\ 420\ € - 169\ 930\ € = 94\ 490\ €$$

(17):

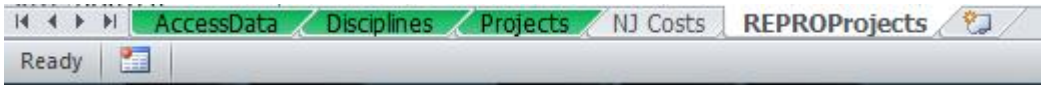
$$Profit\ Ratio\ (\%) = \frac{Project\ Total\ Sales - Project\ Full\ Costs}{Project\ Full\ Costs}$$

$$= \frac{Project\ Total\ Sales}{Project\ Full\ Costs} - 1$$

$$Profit\ Ratio\ (\%) = \frac{264\ 420\ €}{169\ 930\ €} - 1 = 55{,}6\ \%$$

Appendix 4. Overview of the Project Profitability Estimation Tool (PPET)

In this Appendix the PPET the overview of PPET with made-up values is shown. PPET contains 3 main worksheets and 2 hidden worksheets.



Picture 2. The main three worksheets of PPET (marked in green). And two additional worksheets.

	A	B	C	D	E	F	G	H
1	Get Data		Last Updated 22.06.2015	Get Data beginning from date:		1.1.2015		
2	ID	Code	Activity	Discipline	Hours	CustomerPrice	StartDate	EndDate
3	634	P00002	1100	1100 Project Management	40	70,0 €	29.6.2015	27.10.2015
4	635	P00002	1105	1105 Project Control	55,00	70,0 €	29.6.2015	27.10.2015
5	636	P00002	1110	1110 Process Engineering	40,00	80,0 €	29.6.2015	27.10.2015
6	637	P00002	1120	1120 Electrical Engineering	60,00	90,0 €	29.6.2015	27.10.2015
7	638	P00002	1130	1130 Instrumentation Engineering	200,00	100,0 €	29.6.2015	27.10.2015
8	639	P00002	1140	1140 Layout and Piping Engineering	100,00	80,0 €	29.6.2015	27.10.2015
9	640	P00002	1152	1152 Steel Structural Engineering	40,00	90,0 €	29.6.2015	27.10.2015
10	641	P00002	1160	1160 HSE Engineering	10,00	80,0 €	29.6.2015	27.10.2015

Picture 3. Accessdata –worksheet (1/2). Accesdata worksheet contains a straight data dump from PPET database with a few additional calculated fields. The user can select the timeline for the data request and then click “Get Data” –button.

I	J	K	L	M	N	O	P	Q	R
FSCode	Added	Type	Total Sales	Full Costs	Max Direct Costs	Gross Margin	Operating Profit	Profit %	ERP
P00001	16.6.2015	Execution	2 870,00 €	3 298,00 €	2 137,95 €	732,05 €	-428,00 €	-14,91 %	FALSE
P00001	16.6.2015	Execution	3 946,25 €	3 606,35 €	1 956,35 €	1 989,90 €	339,90 €	8,61 %	FALSE
P00001	16.6.2015	Execution	3 280,00 €	2 852,40 €	1 652,44 €	1 627,56 €	427,60 €	13,04 %	FALSE
P00001	16.6.2015	Execution	5 535,00 €	4 189,80 €	2 390,01 €	3 144,99 €	1 345,20 €	24,30 %	FALSE
P00001	16.6.2015	Execution	20 500,00 €	14 422,00 €	8 422,08 €	12 077,92 €	6 078,00 €	29,65 %	FALSE
P00001	16.6.2015	Execution	8 200,00 €	6 710,00 €	3 710,82 €	4 489,18 €	1 490,00 €	18,17 %	FALSE
P00001	16.6.2015	Execution	3 690,00 €	2 714,80 €	1 514,87 €	2 175,13 €	975,20 €	26,43 %	FALSE
P00001	16.6.2015	Execution	820,00 €	678,70 €	378,72 €	441,28 €	141,30 €	17,23 %	FALSE

Picture 4. Accessdata –worksheet (2/2). The automatically calculated fields (from column L to R) are calculated when the data is brought to PPET.

	A	B	C	D	E	F	G	H
1	Discipline Specific Profitability							
2	Discipline	Hours	Sales	Full Costs	Max Direct Cost	Operating Profit	Gross Margin	Average Profit %
3	1100 Project Management	0	0 €	0 €	0 €	0 €	0 €	0,00 %
4	1105 Project Control	0	0 €	0 €	0 €	0 €	0 €	0,00 %
5	1110 Process Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
6	1111 Process Technology	0	0 €	0 €	0 €	0 €	0 €	0,00 %
7	1112 Automation Technology	0	0 €	0 €	0 €	0 €	0 €	0,00 %
8	1120 Electrical Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
9	1130 Instrumentation Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
10	1140 Layout and Piping Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
11	1151 Civil and Structural Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
12	1152 Steel Structural Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
13	1160 HSE Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
14	1180 Automation Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
15	1190 Equipment Engineering	0	0 €	0 €	0 €	0 €	0 €	0,00 %
16	1170 Procurement	0	0 €	0 €	0 €	0 €	0 €	0,00 %
17	1171 Materials and equipment procurement	0	0 €	0 €	0 €	0 €	0 €	0,00 %
18	1172 Purchase of services and contracts	0	0 €	0 €	0 €	0 €	0 €	0,00 %
19	1173 Delivery control and inspection	0	0 €	0 €	0 €	0 €	0 €	0,00 %
20	1200 Process Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
21	1210 Electrical Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
22	1220 Instrumentation Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
23	1231 Piping Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
24	1241 Civil, Structural Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
25	1242 Steel Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
26	1250 Construction Mgmt	0	0 €	0 €	0 €	0 €	0 €	0,00 %
27	1260 HSE Field Supervision	0	0 €	0 €	0 €	0 €	0 €	0,00 %
28	1270 Warehouse	0	0 €	0 €	0 €	0 €	0 €	0,00 %

Picture 5. Discipline specific view. In the discipline specific sheet, the user can see the amount of hours per discipline that are in the database within the selected timeline.

	A	B	C	D	E	F	G	H
1	Project Specific Profitability							
2	Project	Hours	Total Sales [€]	Full Costs	Max Direct Costs	Gross Margin	GM %	Operating Profit
3	P00002	545	40 000,00 €	25 000,00 €	20 000,00 €	20 000,00 €	50,00 %	15 000,00 €

Picture 6. Project Specific view (1/2). Below the headers all the projects and their information within the selected timeline are shown.

I	J	K	L	M	N
Profit [%]	Estimated Start Date	Estimated End Date	Project Duration	Phase	Added to Database
60,00 %	20.6.2015	18.9.2015	90 d	Execution	16.6.2015

Picture 7. Project Specific view (2/2).