

A study of the PIMS Cost Management Module

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This master's thesis is carried out as a part of the education at the University of Agder and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

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Abstract

Working with cost management in complex projects in today's society is a comprehensive task. The need for supporting tools is therefore increasing, where specific tools like Project Management Information Systems (PMIS) are becoming more necessary in order to manage projects more efficiently.

This thesis aims to investigate the effects of utilizing a PMIS called Project Information Management System (PIMS), and search for how the systems Cost Management Module (CMM) could contribute in the cost management processes in complex projects. Based on this, the research question was: *What are the effects of utilizing the PIMS Cost Management Module in complex projects?*

In order to detect a wide range of effects, we performed interviews with the developer of the system (Omega AS) as well as relevant customers with experience in using the PIMS CMM in the cost management of complex projects.

The research showed several positive effects of utilizing the CMM. By having a centralized database it enabled the companies to generate reliable and updated information to extract reports and execute analysis in order to improve project performance. Another effect was how the system had several features to simplify the cost management processes, such as the ability to allocate human resources as well as timephase costs. However, some issues concerning transfer and loss or lack of information were mentioned as negative effects. In addition factors emerged that could have an impact on utilizing the system successfully, such as the need to apply various additional tools and to acquire sufficient knowledge about, and experience with, the system. To summarize, a common agreement was that utilizing the PIMS CMM was necessary in order to efficiently execute cost management in complex projects, but that there are some potential improvements to the system.

From our research the effects supported by theory were: centralized database, improved project performance, simplified processes, change management and historical information and experience. The effects that could be considered as supplements to the existing theory were: reduced dependency, higher quality of information and issues regarding information. Additional tools and ease of use were categorized as factors that could have an impact on achieving the effects.

Contents

Acknowledgements.....	i
Abstract.....	ii
List of figures.....	vi
List of tables.....	vii
1.0 Introduction.....	2
1.1 Background.....	2
1.2 Motivation.....	2
1.3 Research question	3
2.0 Theory.....	5
2.1 Structure of the theory	5
2.2 The concept of project and project control	6
2.3 Project management information system.....	8
2.3.1 PMIS – challenges and values	9
2.3.1.1 Challenges concerning a PMIS	10
2.3.1.2 Potential values concerning a PMIS	11
2.4 Cost Management	13
2.4.1 Resource planning.....	14
2.4.1.1 Inputs.....	15
2.4.1.2 Tools and techniques.....	16
2.4.1.3 Outputs.....	16
2.4.2 Cost estimating.....	16
2.4.2.1 Inputs.....	17
2.4.2.2 Tools and techniques.....	17
2.4.2.3 Outputs.....	18
2.4.3 Cost budgeting	18
2.4.3.1 Inputs.....	18
2.4.3.2 Tools and techniques.....	19
2.4.3.3 Outputs.....	19
2.4.4 Cost control.....	19
2.4.4.1 Inputs.....	20
2.4.4.2 Tools and techniques.....	20
2.4.4.3 Outputs.....	22
2.5 The Cost Management Module of PIMS	22
2.6 Preliminary Summary	27
3.0 Research methodology.....	29

3.1 Choice of method.....	29
3.2 Sampling method and data collection	30
3.2.1 In - depth interviews and the structure	30
3.2.2 Interview guide	31
3.2.3 Sampling design.....	32
3.2.4 The respondents	33
3.2.5 The interview setting.....	34
3.3 Data Analysis.....	36
4.0 Empirical observations.....	38
4.1 Resource planning.....	38
4.1.1 The respondents use of the PIMS CMM.....	39
4.1.2 The respondents thoughts of not using the PIMS CMM.....	41
4.2 Cost Estimating.....	42
4.2.1 The respondents use of the PIMS CMM.....	42
4.2.2 The respondents thoughts of not using the CMM.....	45
4.3 Cost Budgeting	46
4.3.1 The respondents use of the CMM	47
4.3.2 The respondents thoughts of not using the CMM.....	48
4.4 Cost Control.....	50
4.4.1 The respondents use of the CMM	51
4.4.1.1 The process of implementing actual costs	51
4.4.1.2 The process of forecasting	52
4.4.1.3 The change module and contingency.....	54
4.4.1.4 Centralized database and reports.....	56
4.4.2 The respondents thoughts of not using the CMM.....	58
4.5 Potential improvements	60
4.6 Comments on empirical observations	62
5.0 Discussion.....	64
5.1 Effects supported by theory	64
5.1.1 Centralized database	65
5.1.2 Improved project performance.....	65
5.1.3 Simplified processes	67
5.1.4 Change Management	68
5.1.5 Historical information and experience	69
5.2 Effects that supplements existing theory	69
5.2.1. Reduced dependency	69

5.2.2 Higher quality of information	70
5.2.3 Issues regarding information.....	71
5.3 Factors that could have an impact on the effects	71
5.3.1 Additional tools.....	72
5.3.2 Ease of use	72
5.4 Summary of discussion	73
6.0 Concluding Remarks.....	76
Bibliography	79
Appendix 1: Intervjuguide til Omega på norsk.....	82
Appendix 2: Interview guide to Omega in English.....	85
Appendix 3: Intervjuguide til bedriftene på norsk	89
Appendix 4: Interview guide to the companies in English	93

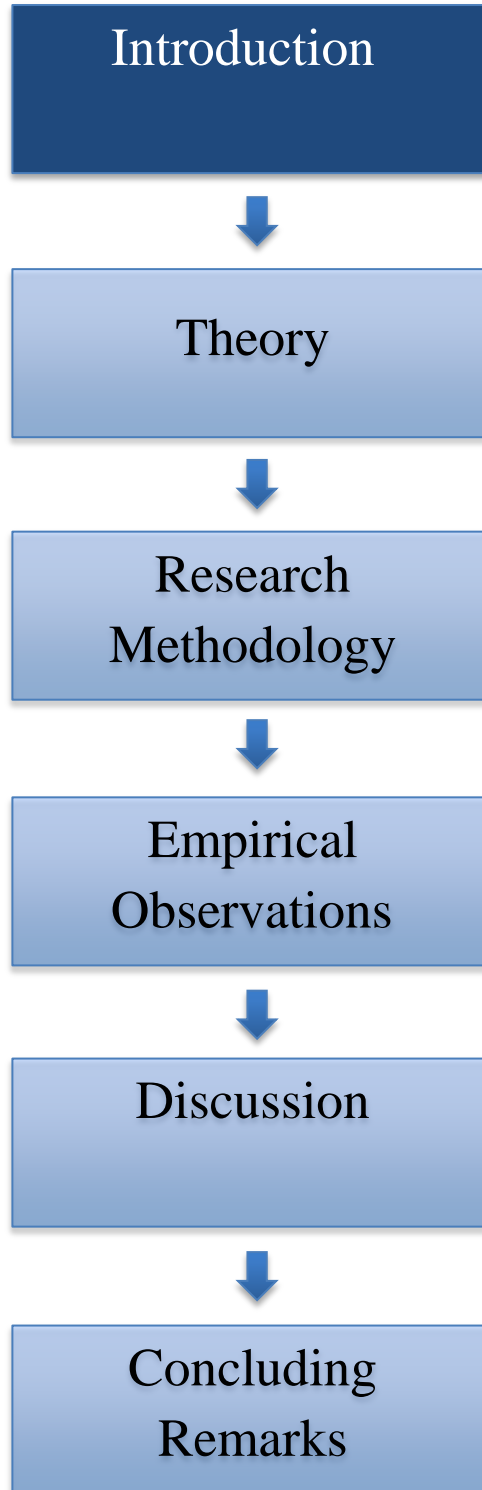
List of figures

Figure 2.1: Structure of the theory	5
Figure 2.2: Project control (Rolstadås 2011,p.56)	7
Figure 2.3: IT and business value – a fundamental framework (Christensen, Methlie et al. 1999,p.30). 9	
Figure 2.4: Project Cost Management (PMI 1996).....	14
Figure 2.5: The process of resource planning	15
Figure 2.6: Example of Work Breakdown Structure (Omega 2012)	15
Figure 2.7: The process of cost estimating	17
Figure 2.8: The process of cost budgeting	18
Figure 2.9: The process of cost control.....	20
Figure 2.10: Overview of PIMS and PIMS Cost Management (Omega AS 2012)	23
Figure 2.11: Monthly Reporting Process (Omega 2012).....	25
Figure 2.12: Updating the personnel cost and man-hour forecast (Omega 2012)	26
Figure 2.13: Expected values of utilizing the PIMS CMM	27
Figure 5. 1: Effects of utilizing the PIMS CMM	74

List of tables

Table 2.1: Characteristics of complex projects (Wysocki 2010)	6
Table 2.2: Controlling variables (Rolstadås 2001, Karlsen and Gottschalk 2005)	8
Table 2.3: Potential values of a PMIS (Vik 2013)	11
Table 2.4: Values of a PMIS (Thomsen 2011)	12
Table 2.5: WBS detail levels (Rolstadås 1997, p.130)	16
Table 3. 1: The respondents	34

Chapter 1 – Introduction



1.0 Introduction

This chapter describes the background and motivation for our research and explains the research question of the thesis.

1.1 Background

The development of worldwide competitive markets and the desire to achieve competitive advantage has made the current business environment complex (Elonen 2003). In organizations that are engaged in several complex projects simultaneously, management is faced with multiple challenges and a need for the projects to be properly managed through planning, scheduling, organizing, monitoring and controlling (Liberatore and Pollack-Johnson 2003). The need for supporting tools for managing the project increases, where specific tools like Project Management Information Systems (PMIS) are becoming more or less a prerequisite in order to manage projects more efficiently (Karim 2011). On behalf of our principal Omega AS (hereafter Omega) we wanted to look closer on their Project Information Management System (PIMS) and more specific the Cost Management Module (CMM).

1.2 Motivation

The motivation for the thesis was to do research on a theme related to our specialization in project management with additional focus on business. Project Cost Management consists in theory of four main elements; resource planning, cost estimating, cost budgeting and cost control, which are relatively well-known business concepts. Even though PIMS' main focus is the processes of cost budgeting and cost control, our aim for this thesis is to consider the complete cost management process. We will therefore search for how the utilization of the PIMS CMM in the cost management processes could generate potential effects, both positive and negative.

It has been a great opportunity for us to write for an international company like Omega with focus on their CMM. Omega is supplying highly qualified personnel and developing software solutions to an extensive client base. They are operating in different parts of Norway as well as eight other countries worldwide. Starting up as a small company in Ølen, the company had by 2010 over 1000 staff and a turn-over of one billion NOK.

1.3 Research question

The world is experiencing an extensive use of information technology (IT) and an enormous amount of money is being used on IT applications every year (Karim 2011). Research has shown various effects of a PMIS, where key words as automated processes, extensive controlling possibilities and increased performance are used to describe some of them (Thomsen 2011, Vik 2013). However, what are the perceived benefits of utilizing the PIMS CMM with respect to cost management? Is it necessary to have a project management system in order to manage complex projects? Are there only positive effects of utilizing the PIMS CMM, or are there any negative effects as well? Are there any prerequisites or potential improvements of utilizing such a system?

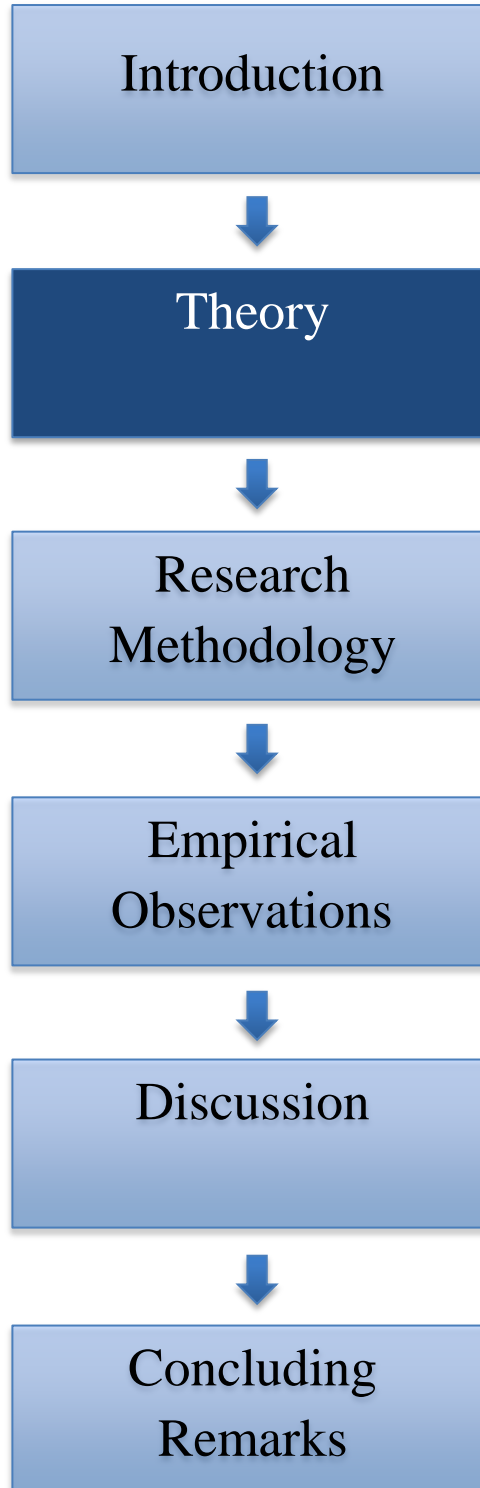
On the basis of this, our research question was:

What are the effects of utilizing the PIMS Cost Management Module in complex projects?

Our research concentrated on a sample of Omegas customers to search for positive and negative effects based on their experience of utilizing the PIMS CMM in complex projects. As companies involved in complex projects typically have experience with utilizing a system like PIMS, we decided to limit our research to these companies to detect a greater range of effects. Our aim was to achieve a broader understanding of how the CMM was influencing the users' daily work when operating with cost management. Based on this, we searched for the effects of utilizing the PIMS CMM in the cost management processes.

We have tried to address a new area of knowledge, as no previous research exists on the effects of PIMS. We hope this research will be of interest to Omega in terms of using potential positive effects in order to convince new customers to implement and utilize the system, as well as considering the possible negative for effectuating potential improvements to the system.

Chapter 2 – Theory



2.0 Theory

In this chapter we will introduce the theory and previous research to achieve a better understanding in order to answer the research question.

2.1 Structure of the theory

The presentation of the theory begins with an introduction of the main characteristics of a project and project complexity, and then continues with an explanation of project control. Further we will give a review of IT where the focus will be on how a PMIS can generate values, but also on challenges that need to be considered. Theory concerning the cost management processes in projects will be presented before concluding with an explanation of Omega's product PIMS and more specifically the CMM. An overview of how the theory will be reviewed is illustrated in Figure 2.1.

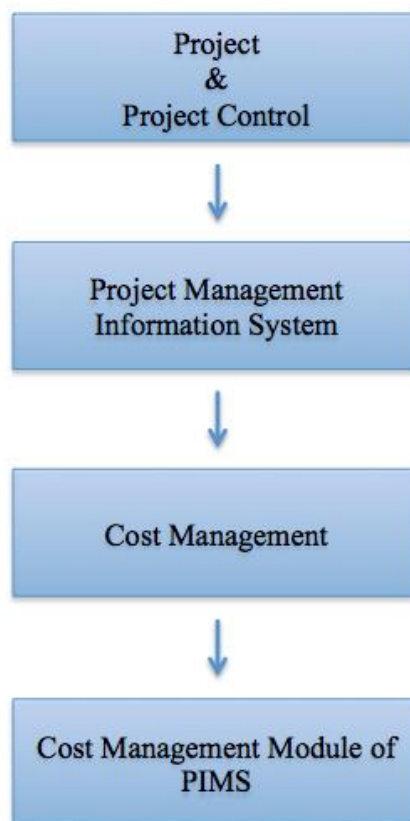


Figure 2.1: Structure of the theory

2.2 The concept of project and project control

A project can be defined as “an endeavor to accomplish a specific objective through a unique set of interrelated tasks and the effective utilization of resources” (Gido and Clements 2012 ,p. 18). Even though projects may differ in size, complexity, time frame etc., there are some main characteristics. Christensen and Kreiner (1991) highlight five:

- A one- time business
- A unique goal achievement
- A limited access to resources
- A specific start and ending date
- Interdisciplinary work

As our thesis is concerned with complex projects it is important to know what typically characterizes project complexity. Wysocki (2010) discusses that a projects complexity is positively correlated with uncertainty and further on state that the degree of complexity is reflected in the following elements; client involvement, change, risk, communication and team cohesion. Table 2.1 explains the characteristics involved in a complex project.

Table 2.1: Characteristics of complex projects (Wysocki 2010)

Characteristics of complex projects	Description
Client involvement	<ul style="list-style-type: none"> ▪ Requires a high degree of collaboration between the project team and the client. The client needs to participate with the project team and the project team needs to be willing to learn the clients business and demand.
Change	<ul style="list-style-type: none"> ▪ Generally an increased need to receive and process change requests. As the complexity increases, it becomes necessary to make changes in order to achieve an optimal result.
Risk	<ul style="list-style-type: none"> ▪ Complex projects usually consist of several uncertainties and vague elements, which could lead to a higher level of risk exposure. One should therefore spend a considerably amount of time on risk management.
Communication	<ul style="list-style-type: none"> ▪ Complex projects have an extended need for two-way communication such as meetings, where written communication is seen as no added value.
Team cohesion	<ul style="list-style-type: none"> ▪ Complex projects generally require a more autonomous team, and should be co-located. This could lead to more valuable results.

According to Liberatore and Pollack-Johnson (2003) there is an increased need for projects to be properly managed in today's competitive markets. Rolstadås (2011) states how research has proven that proper project control plays a crucial role in project success. Project control is, according to him, separated into planning and monitoring, where cost, time and work scope are referred to as some of the most important controlling variables. The coherence is illustrated in Figure 2.2 where costs are highlighted, as it is the main focus of this research.

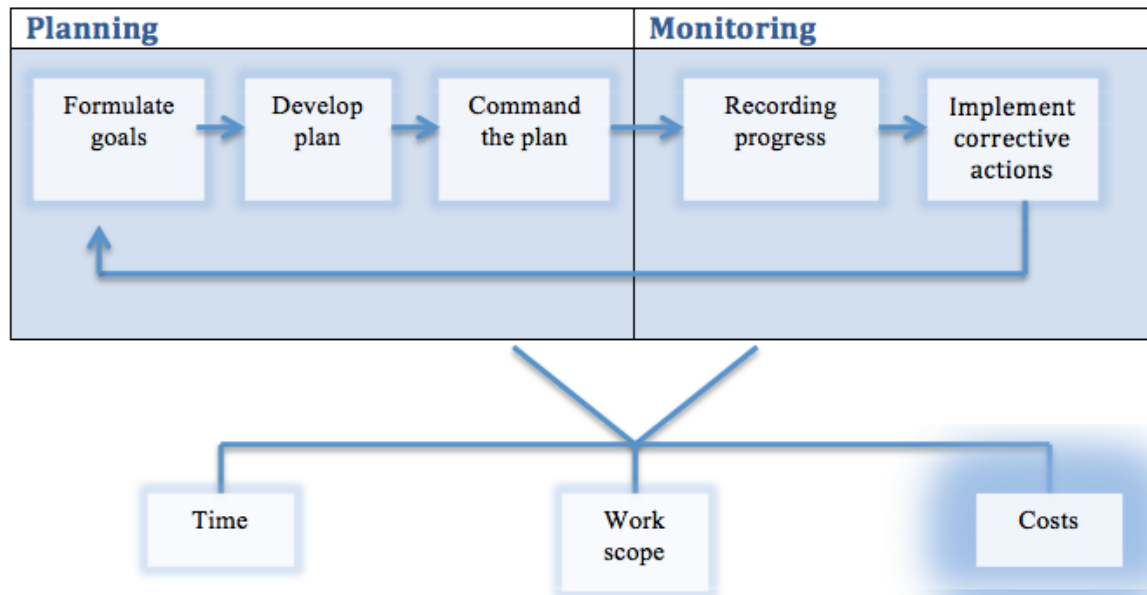


Figure 2.2: Project control (Rolstadås 2011,p.56)

Planning is concerned with composing various plans in order to know how to execute a project. There are usually prepared plans concerned with time, cost and work scope of the project. The process of planning could be divided into three main tasks which are formulating goals, developing plan and commanding the plan. The process of planning is usually performed in the early stages of the project. The process of monitoring refers to making sure that plans are followed and goals are reached with focus on recording progress and implementing corrective actions (ibid).

As previously stated, some of the most important controlling variables are cost, time and work scope. These variables need to be continuously planned and monitored throughout the project, and a short explanation why is given in Table 2.2.

Table 2.2: Controlling variables (Rolstadås 2001, Karlsen and Gottschalk 2005)

Controlling Variables	
Cost	<ul style="list-style-type: none"> Cost concerns all sacrifices that are made to complete the project measured in money. It is important to control costs in all types of projects, due to the possibility of major consequences in case of budget overrun.
Time	<ul style="list-style-type: none"> This variable defines how much time that is necessary to ensure completion of the project. To get an overview of the project progress is crucial. Generally, a Gantt- chart with an overview on how the project is developing in coherence with the original time schedule is being used.
Work Scope	<ul style="list-style-type: none"> Work scope consists of what has to be done to produce and achieve the end result in terms of activities required for the implementation. In projects one usually breaks down individual activities in a “Work Breakdown Structure” (WBS). By using a WBS one could easily identify the work scope. If changes are to be done, the work scope needs to be changed accordingly.

In complex projects there is an increased need for comprehensive communication and advanced technological solutions in order to plan and coordinate all parts to meet business goals (Vik 2013). As the process of project control can be comprehensive, a powerful project management software is sometimes a prerequisite to manage the project more efficiently and effectively considering cost, time and work scope (Karim 2011). An introduction of IT and a PMIS will be presented next along with the values and challenges a PMIS might generate.

2.3 Project management information system

IT is in today’s society becoming more important as a tool for collection, transferring, processing, storing and presenting information in an efficient way (Gottschalk 1998). The need for such efficiency is part of the growing appetite for information, but also the requirement for faster and more accurate information. Technology has a major impact on the society in different areas, and for a company it could influence both inside and outside factors. From an inside perspective technology can create new opportunities. Using IT automates processes to

improve cost efficiency and in addition function as a great coordination mechanism. The company is also facing technology changes from outside, where IT creates new forms of communication between companies and between the companies and their markets. Inter-organizational relations are increasing and distance is no longer a major problem when communicating and collaborating. Technology could therefore create opportunities with respect to new markets, new products/ services and inter-organizational alliances where the target is to achieve a competitive advantage (Christensen, Methlie et al. 1999).

The value of the IT is not in the technology itself, but in its deliberate, targeted application (Christensen, Methlie et al. 1999). IT itself does not create business value. IT is most interesting in terms of to what level it contributes to solve the company's tasks and problems or how it helps the company reach its goals. Value creation requires a deliberated and targeted use of technology and develops an optimal relationship among information technology, business strategies, goals and processes. Implementing IT is therefore not directly linked with adding business value, but with improving the business processes, which could generate value (ibid). This concept is illustrated in Figure 2.3.

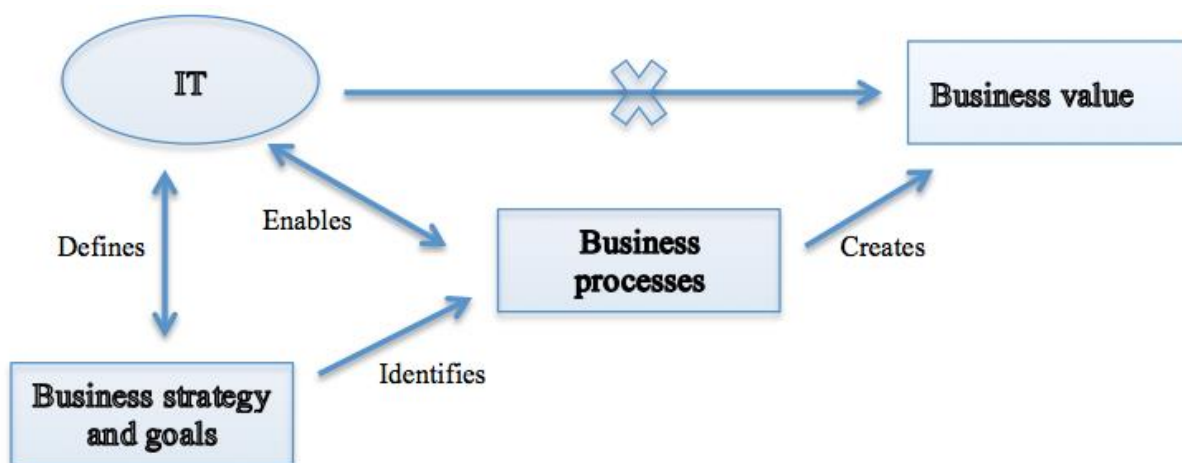


Figure 2.3: IT and business value – a fundamental framework (Christensen, Methlie et al. 1999,p.30)

2.3.1 PMIS – challenges and values

A PMIS is a commonly used IT-based tool in projects and can be defined as “a computer system for processing project data in order to provide information to facilitate project management actions” (Humphreys and English 1993,p.228). A PMIS is mainly concerned with documenting and communicating project information; consequently getting the right information in the right format to the right person at the right time (ibid).

Some research has been done on possible challenges and values of a PMIS, however the research is somewhat limited (Cania'ls 2011). We have therefore decided to focus on two aspects of research by Vik (2013) and Thomsen (2011). We will first present some challenges related to a PMIS before continuing with potential values of a PMIS.

2.3.1.1 Challenges concerning a PMIS

Vik (2013) discusses various challenges that could function as an initiator to implementing a PMIS. Some relevant challenges could be:

- *Increased project size and complexity*
Bigger and more complex projects generate a higher risk which leads to an increased need for communication and coordination. A complex project needs to be sufficiently planned with the use of technological solutions to meet business objectives.
- *Information overload*
In a complex project there is an extensive need to store and share a comprehensive amount of information. The struggle to quickly identify the relevant information when needed is a major challenge.
- *Overreliance on rudimentary system*
A high number of complex projects manage costs by relying on manual processes and rudimentary information systems. Microsoft Excel is commonly used as a cost control system which isolates the cost control to one team member.

Thomsen (2011) on the other hand discusses different challenges that could arise when deciding to actually implement a PMIS, where some examples are presented below:

- *Technical support*
In a case where team members do not have knowledge and experience with using a PMIS it could result in a reduced effect of implementing the system. Additional technical support during start-up will then be important.
- *Interoperability*
Implementing a PMIS should create the opportunity to easily exchange information between the company and others. This can be a challenge if outsourced companies have their own integrated system.

- *Resistance*

Usually the most experienced members look at updating the information in the PMIS as administrative work, and not as a part of the project. This could result in treating the PMIS as an afterthought, which could lead to loss of important information.

Like any other IT systems, a PMIS cannot fix these challenges in itself, but it can generate information to people in order for them to more effectively achieve project goals. However, the connection between implementing a PMIS and achieving business value can be difficult to detect, but it could be more understandable by looking at some possible values of a PMIS (Humphreys and English 1993, Thomsen 2011).

2.3.1.2 Potential values concerning a PMIS

Vik (2013) expresses the importance of taking advantage of available technology to make the project team more efficient. He also expresses the importance of focusing more on analytics rather than gathering data, developing reports and other manually work aspects. He further emphasizes key aspects of a PMIS that enable the system to deliver tangible values. Some of the potential values are presented in Table 2.3.

Table 2.3: Potential values of a PMIS (Vik 2013)

Potential values	
One-Stop Shop	<ul style="list-style-type: none"> ▪ A PMIS is designed to collect information from various sources in a project to collocate them in one single database. This centralized database makes it easier to stay focused on important tasks because one does not have to work with a number of overlapping systems trying to tie the ends together.
Transparency and Accountability	<ul style="list-style-type: none"> ▪ Using a system like a PMIS enables a secure sharing of information between parties involved in the project. In addition it provide information regarding project deliverables, various tasks and activities, responsibilities regarding document completion and makes it possible to do an auditable approval process.
Efficient Change Management	<ul style="list-style-type: none"> ▪ An effect of using a PMIS is that one is able to do a more efficient change handling, which is of major importance in complex projects. Such a system has thorough procedures to simplify the process of identifying, documenting and approving changes as well as contingency.

Team Integration and Communication	<ul style="list-style-type: none"> An important value of using a PMIS is that it contributes towards keeping everybody together and focused on a successful project completion. A system like this has the ability to integrate contract management with the cost engineers, risk management with project controls etc., to provide various tools to handle information exchanges and critical workflows.
Focus until Completion	<ul style="list-style-type: none"> Implementing a PMIS will enable the project team to focus on the final result throughout the project. It will do so by continuously ensuring efficient communication between departments and enable planning and tracking of each work package and/or activity. This makes it easier to picture status, cost and the completion date at all times.
Automate Manual Processing	<ul style="list-style-type: none"> An important value is automating processes. Using a PMIS enables you to automate time-consuming processes like reporting, and makes more time for analyzing and interpreting the information to be able to provide important recommendations and forecasts.
Speed and Flexibility	<ul style="list-style-type: none"> Another value of implementing a PMIS is that it will standardize a lot of sensible processes. In addition it will make it possible to simply adapt the system to your project in order to stay focused and at the same time deliver a positive impact to the project.
Capture Experience and Benchmarking Data	<ul style="list-style-type: none"> An important value of using a PMIS is that it enables you to capture information from experience and benchmarking regarding your project. It is then possible to analyze and compare this information.

Thomsen (2011) has also some aspects concerning values that can be generated by a PMIS. The potential values achieved from his research are presented in Table 2.4.

Table 2.4: Values of a PMIS (Thomsen 2011)

Potential values	
Information for common understanding: a prerequisite for collaboration	<ul style="list-style-type: none"> A PMIS will help to gather and share information among people, which can result in cohesion. This could lead to a better understanding of the project for all team members. Through a PMIS the information is available whenever needed, and one does not get confused with conflicting data and dissimilar filing cabinets.

The cheapest and most reliable way to document and communicate information	<ul style="list-style-type: none"> ▪ Using a PMIS is a cheaper and more reliable way of documenting and communicating information, as the data only needs to be collected and recorded once. The information is then automatically forwarded to the team, which reduces the possibility of duplication and is more efficient and reliable.
Armor for defense against political or legal attack	<ul style="list-style-type: none"> ▪ A PMIS could advantageous assist with sufficient, centralized and well-documented information when a potential conflict occurs. Well-documented information about the project is then increasing the possibility of winning a potential attack.
Window into the project	<ul style="list-style-type: none"> • Implementing a PMIS could simplify the manager's process of controlling the project. A PMIS could give information about what has happened, what is going on in the project, and what is the likely outcome of the current state of affairs. By using a PMIS one could decide who has access to various types of information by using defined levels of passwords protection.
Improving performance with report cards	<ul style="list-style-type: none"> ▪ A PMIS could be used to report actual progress against the objectives of the project and thus develop reports for managers to make use of. As a result it could show how the project team works and could result in improved performance.
Educating management	<ul style="list-style-type: none"> • Using a PMIS could improve management because one uses accurate project history which generates a better understanding. This could result to improved and experienced leaders that are attractive to owners.

As a summary there are challenges that function as an initiator for implementing a PMIS as well as challenges that may arise when deciding to implement it. However, a PMIS can generate several added values, which could assist in managing the project more efficiently. As our thesis is concerned with the effects of utilizing the PIMS CMM, it is necessary to introduce theory regarding the processes of cost management. This is done to obtain a better understanding of cost management in general and how it is possible to achieve potential benefits by using a project management system like PIMS when executing these cost management processes.

2.4 Cost Management

“Project Cost Management describes the processes required to ensure that the project is completed within the approved budget. It consists of resource planning, cost estimating, cost

budgeting and cost control” (Omega 2012,p.3). Each of these processes could be characterized by its inputs, the tools and techniques that could be applied and the resulting outputs. This is illustrated in Figure 2.4.

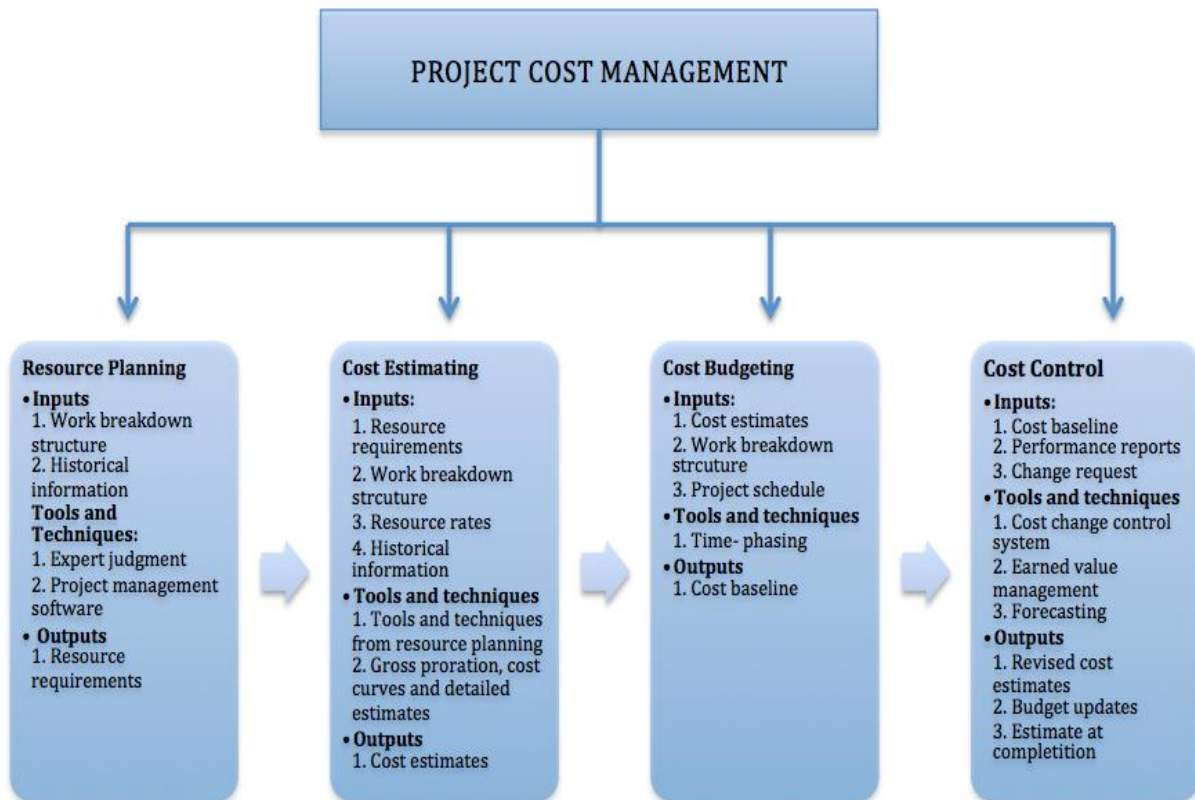


Figure 2.4: Project Cost Management (PMI 1996)

As illustrated in Figure 2.4, the four processes interact with each other and in practice they may overlap. Each process occurs at least once in every project and if the project consists of several phases they might occur in several project phases. To get a better understanding of cost management we have decided to discuss each process taking into consideration what we consider as relevant regarding inputs, tools and techniques used and the following outputs of the process (Project Management 2008).

2.4.1 Resource planning

Resources can consist of different factors such as labor, equipment, material etc. Resource planning involves determining what type and quantity of each resource that should be used to perform the individual project activities. The purpose of resource planning is to allocate

resources per unit of time so that the work can be implemented without unnecessary consumption of resources (Kolltveit and Reve 1998).

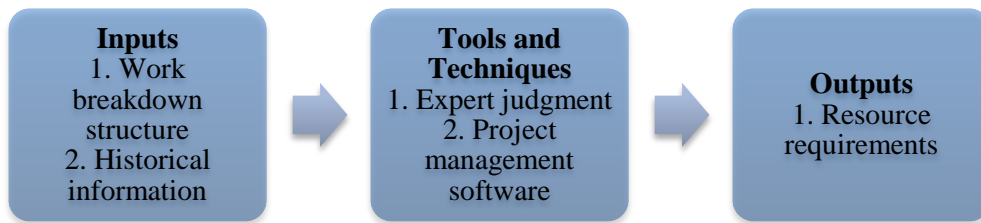


Figure 2.5: The process of resource planning

2.4.1.1 Inputs

There are various types of inputs used in the process of resource planning. One of the more important inputs is the WBS, but historical information could also be relevant.

Work Breakdown Structure

To get an outline on category, quantity and quality of resources required throughout the project it is beneficial to compose a WBS. The WBS is the primary input in resource planning because each work package or activity contains a given set of resources needed (Karlsen and Gottschalk 2005).

A WBS is therefore a way of hierarchically structuring the work scope of the project and related resources. One could say that a WBS illustrates a map of the project, where the goal is to simplify the process of planning and monitoring (Granli, Hetland et al. 1986). Karlsen and Gottschalk (2005) states that a WBS is supposed to contribute to, among others, the two following elements by illustrating:

- The different activities that constitute a part of the project
- The relationship between these activities

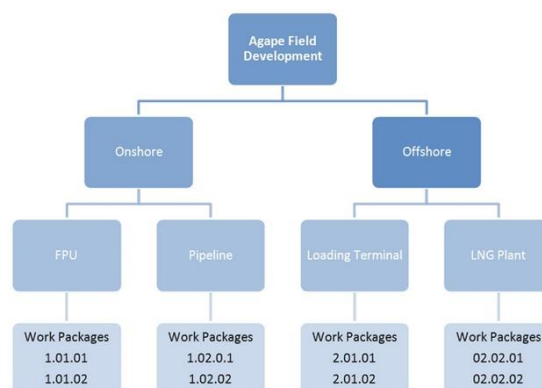


Figure 2.6: Example of Work Breakdown Structure (Omega 2012)

The number of levels used to break down a project depends on the preferences with regard to the level of detail. According to PMI (2008) a work package is usually the lowest level in a WBS. Possible detail levels are illustrated in Table 2.5.

Table 2.5: WBS detail levels (Rolstadås 1997, p.130)

Work Breakdown Structure
Project
Subproject
Control center
Work package
Activity

Another input in resource planning is historical information from previous projects. A complex project usually consist of several sub-projects, hence there could be available historical information from similar projects. This could simplify the decision process concerning type and quantity of resources (PMI 1996).

2.4.1.2 Tools and techniques

Various tools and techniques could be used for resource planning where some are explained below.

Expert judgment is a frequently used technique where people with specific qualifications could be of assistance in resource planning. Companies could use various sources to get hold of experts such as consultants, units within the same organization etc. Their judgment could be an asset in developing a precise resource requirement plan (PMI 1996).

Project management software could also be used, where various tools could simplify the process of allocating resources. Using software for these purposes could be time saving, even if it may be costly to implement.

2.4.1.3 Outputs

Resource requirements are usually the output from the resource planning process. This requirement should consist of type and quantity of each individual resource that are needed to complete the project (PMI 1996).

2.4.2 Cost estimating

A project consists of various types of resources, where the related costs have to be estimated. According to Granli, Hetland et al. (1986,page 140), “a cost estimate is a forecast of the total

project cost”. This implies that estimates are approximate values with uncertainty attached to them. The purpose of cost estimation is to develop a basis for cost budgeting and cost control, meaning that the cost estimates should be as close as possible to the actual costs.

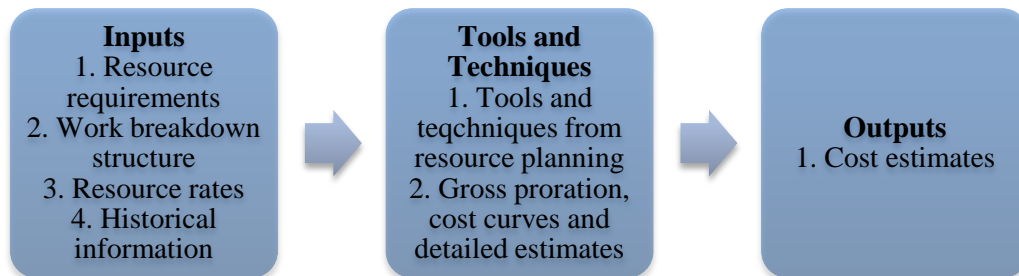


Figure 2.7: The process of cost estimating

2.4.2.1 Inputs

Inputs regarding cost estimating could vary tremendously between companies, thus only a sample of elements will be discussed.

Resource requirements from section 2.4.1.3 function as an input to estimating cost. These requirements could be used to get information regarding the type and quantity of each resource that needs to be estimated, and thus simplify the estimation process (Project Management 2013).

The WBS was detailed explained in section 2.4.1.1 and is also in the process of estimating an essential input since all identified resources need to be estimated and then structured appropriately. The specification of the WBS could therefore have an impact on the accuracy of the cost estimates (ibid).

Exact resource rates are an important input in order to increase the accuracy of the cost estimate. If the resource rates are unknown these rates usually need to be estimated as well (PMI 1996).

By using historical information this could result in a more accurate estimate preparation. It is possible to exploit various types of sources, and some examples are project files, commercial cost estimates and project team knowledge (ibid).

2.4.2.2 Tools and techniques

Tools and techniques used in cost estimating are often identical to the ones used in resource planning such as expert judgment and project management software (section 2.4.1.2). In addition, Clark and Lorenzoni (1985) discuss six estimation techniques where some examples

are gross proration and detailed estimates. As this is of less relevance to our thesis, we will provide no thorough explanation. What could be emphasized is that different techniques vary in terms of maturity and accuracy. A gross proration estimate is the least accurate estimate used in early phases and with a degree of uncertainty of +/- 40 %. The most detailed estimate is used in later phases and involves a higher accuracy with a degree of uncertainty of only +/- 5-10 %.

2.4.2.3 Outputs

The output in this process is the cost estimates. A cost estimate is a quantitative prediction of the actual cost expected to occur for various resources throughout the project. The estimates may be presented in various currencies depending on the company, and a cost estimator may display the estimates as cost per unit or total cost, but usually both are presented (PMI 1996).

2.4.3 Cost budgeting

The process of cost budgeting consists of collecting the estimated costs of individual activities or work items to determine an authorized cost baseline. All authorized budgets are included in the baseline.

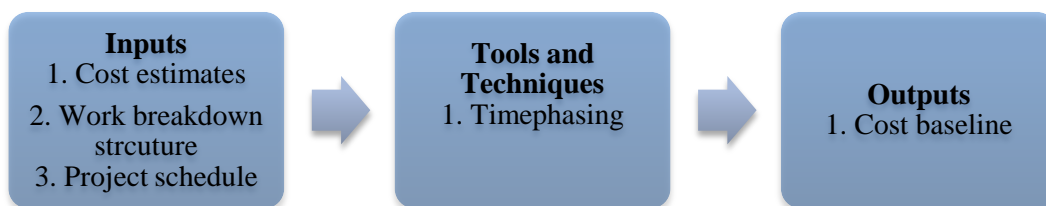


Figure 2.8: The process of cost budgeting

2.4.3.1 Inputs

The initial input in the cost budgeting process is the cost estimates. These estimates are the basis for determining the cost baseline, where the baseline is further used for measuring the progress of the project. If the estimate is of a high accuracy it will generate a more accurate baseline which in turn will result in a more exact performance measurements (Project Management 2008).

The WBS is another important input. When determining the baseline, the WBS is used to identify certain project elements that should be allocated with a specific cost. The WBS works as an overview to simplify the process of generating the cost budget (ibid).

The last input is the project schedule, which consists of planned start and expected finish dates concerning each individual activity. This information needs to be available in order to assign costs for the time period. The project schedule is generally presented with the use of different techniques such as Gantt-charts or network planning (ibid).

2.4.3.2 Tools and techniques

When costs are allocated to the belonging cost objectives in the WBS, the next step is to know when these costs may occur. This is to simplify the process of cost control and could be done with what is called timephasing. Timephasing refers to a process where total costs are being distributed and escalated throughout the project on a time based schedule. The process of timephasing allow for a greater overview of the total project cost as it could illustrate total costs scheduled monthly throughout the project (Omega 2012).

2.4.3.3 Outputs

During execution of the project the primary mission is to know how the project is coming along in terms of reaching predetermined goals. This refers to the importance of a cost baseline which is the output of the cost budgeting process. A cost baseline is an authorized timephased budget at completion (BAC) and is used to measure, monitor and control the progress; hence the total cost performance of the project. The budget baseline is developed from the cost estimates, which means one has to revise the baseline as more accurate estimates are developed (Humphreys and English 1993).

2.4.4 Cost control

Cost control could be defined as “the application of procedures to monitor expenditures and performance against progress of projects or manufacturing operations; to measure variance from authorized budgets and allow effective action to be taken to achieve minimum costs” (Humphreys and English 1993, p.119).

Some important tasks in cost control include monitoring to discover variance from the original plan, ensuring accurate recording of changes in baseline, preventing incorrect changes and informing stakeholders of authorized changes. Cost control involves trying to identify the causes of positive and negative variances. The main advantage of this process is that it provides the opportunity to identify variance from the plan in order to take corrective action and reduce risk (PMI 1996).

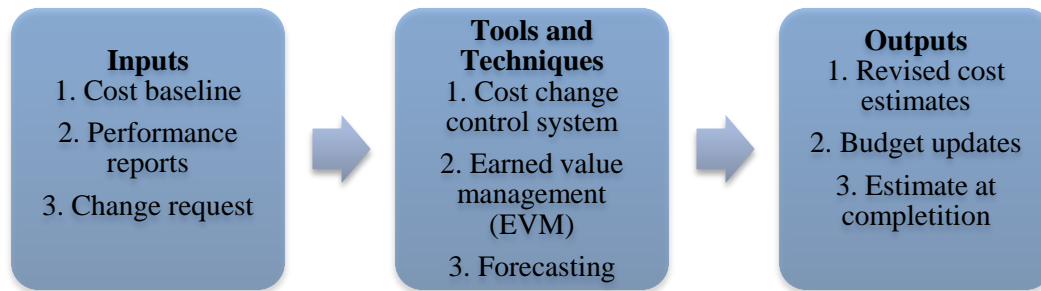


Figure 2.9: The process of cost control

2.4.4.1 Inputs

Several inputs are used to manage cost control, but cost baseline, performance reports and change requests will be our focus.

Cost baseline is the major input in cost control because it enables to measure performance, as the cost baseline works as a comparative element to actual cost. Performance is generally measured with earned value, which will be discussed in section 2.4.4.2. Deviations from the original baseline could lead to potential changes and need for corrective actions (PMI 1996).

Performance reports are results of various analysis of project progress. Performance reports are often presented by the use of Gantt-charts, s-curves, histograms or tables. These reports are usually developed based on Earned Value Management (EVM) (ibid).

Change requests generally arise in conjunction with analysis of project performance. If there are potential delays or budget overruns, this could result in a request for change to meet the goals of the project (ibid). According to Clark and Lorenzoni (1985) it is common to make several changes during the execution of a project. The easiest way to handle these changes is by making use of a change order system, which will be explained in section 2.4.4.2.

2.4.4.2 Tools and techniques

A change order system analyzes the change's impact on cost and schedule and then incorporates this into the budget. An up-to-date baseline is then developed that deviates from the original baseline. Every change has to be documented properly and approved by personnel given the authorization to approve specific changes. By using this system the budget is always up to date and reflects the current project scope and execution plan (Clark and Lorenzoni 1985).

Earned Value Management

The main technique in cost control is the EVM which is used for performance measurement. Principles of this method can be used in all projects, in any industry. The technique compares

the amount of work that was planned with what was actually accomplished. All completed work is then measured against the current control estimate (CCE). This ensures that work is being measured instead of time, costs or resources spent. The method generates an improved forecast of total costs and duration due to the fact that it measures the (current) performance trends. On behalf of this, possible problems and challenges can be seen ahead of time (PMI 2008).

Three fundamental factors have to be known in EVM

- Budgeted cost of work scheduled (BCWS) refers to the authorized budget, also called planned value (PV)
- Actual cost of work performed (ACWP) refers to the actual costs used, also called actual cost(AC)
- Budgeted cost of work performed (BCWP) refers to a portion of the total budget equal to the portion of the work actually completed, also called the earned value (EV) (ibid).

Based on these factors one could calculate performance indices to get a broader overview on the performance of the project. Karlsten and Gottschalk (2005) describe schedule performance index and cost performance index:

- Schedule performance index (SPI) is a measure of the progress of a project, and is measured as

$$\text{Scheduled performance index} = \frac{\text{Earned value (EV)}}{\text{Planned value (PV)}}$$

SPI provides an indication of whether the project is on schedule or not. If the index exceeds 1.0 it signalize ahead of schedule, and less than 1.0 indicates behind schedule.

- Cost performance index (CPI) measures the cost efficiency on work performed and is measured as

$$\text{Cost performance index} = \frac{\text{Earned value (EV)}}{\text{Actual cost (AC)}}$$

CPI is considered to be the most critical EVM metric as it measures the cost efficiency for the work completed. An index value of less than 1.0 indicates a budget overrun, and a value of more than 1.0 refers to budget underrun.

Forecasting

Based on the performance measurements described above one usually develops a forecast for the cost estimate at completion (EAC). This might differ from the BAC, where BAC is the total planned value of the project. If it is obvious that the BAC is no longer reachable one should develop a forecasted EAC. Based on current performance information the process of forecasting the EAC involves making predictions of events that may occur in the future. Forecasts are generated, updated and reissued based on work performance data that is provided through the project lifecycle (Project Management 2013).

Humphreys and English (1993) discuss different methods of calculating EAC where one method presumes that all work will progress at the budgeted rate. This method accepts the actual project performance to date (whether unfavorable or favorable) as shown by the actual costs. It is measured as $EAC = AC + BAC - EV$

2.4.4.3 Outputs

The actual output of cost control varies, but PMI (1996) discuss three different outputs:

Revised cost estimates are a result of performance measurements. Changes due to analysis and new information give birth to a number of revised estimates. Revised cost estimates could lead to a new EAC. One category of revised cost estimates is budget updates. These updates could be referred to as changes to an approved cost baseline. Updates are usually done when the scope of the project changes, but in case of major cost variances this could lead to a revised baseline as well.

Estimate at completion were discussed in the section of forecasting. This is a forecast of project costs based on performance measurement and could be considered as an important output as it could lead to major changes.

Cost management has now been reviewed theoretically, and we will proceed with how cost management could be executed in a practical manner by using the PIMS CMM. This is to generate a broader understanding of PIMS and specifically the CMM by highlighting certain features that our further empirical observations and discussion mainly will be concerned about.

2.5 The Cost Management Module of PIMS

PIMS was introduced in the year 1993, and became Omega's main product when Statoil chose them to develop its project control system. PIMS consists of several modules, all designed to

assist in project control at all levels in an organization. The various modules could be helpful tools towards project success, as project success is concerned with control on all levels (Omega AS 2012).

Figure 2.10 illustrates the available modules that PIMS provide where PIMS Cost Management is highlighted, as this is the core of our research. The figure also illustrates various features included in the CMM, where the highlighted ones are the most relevant to our thesis.

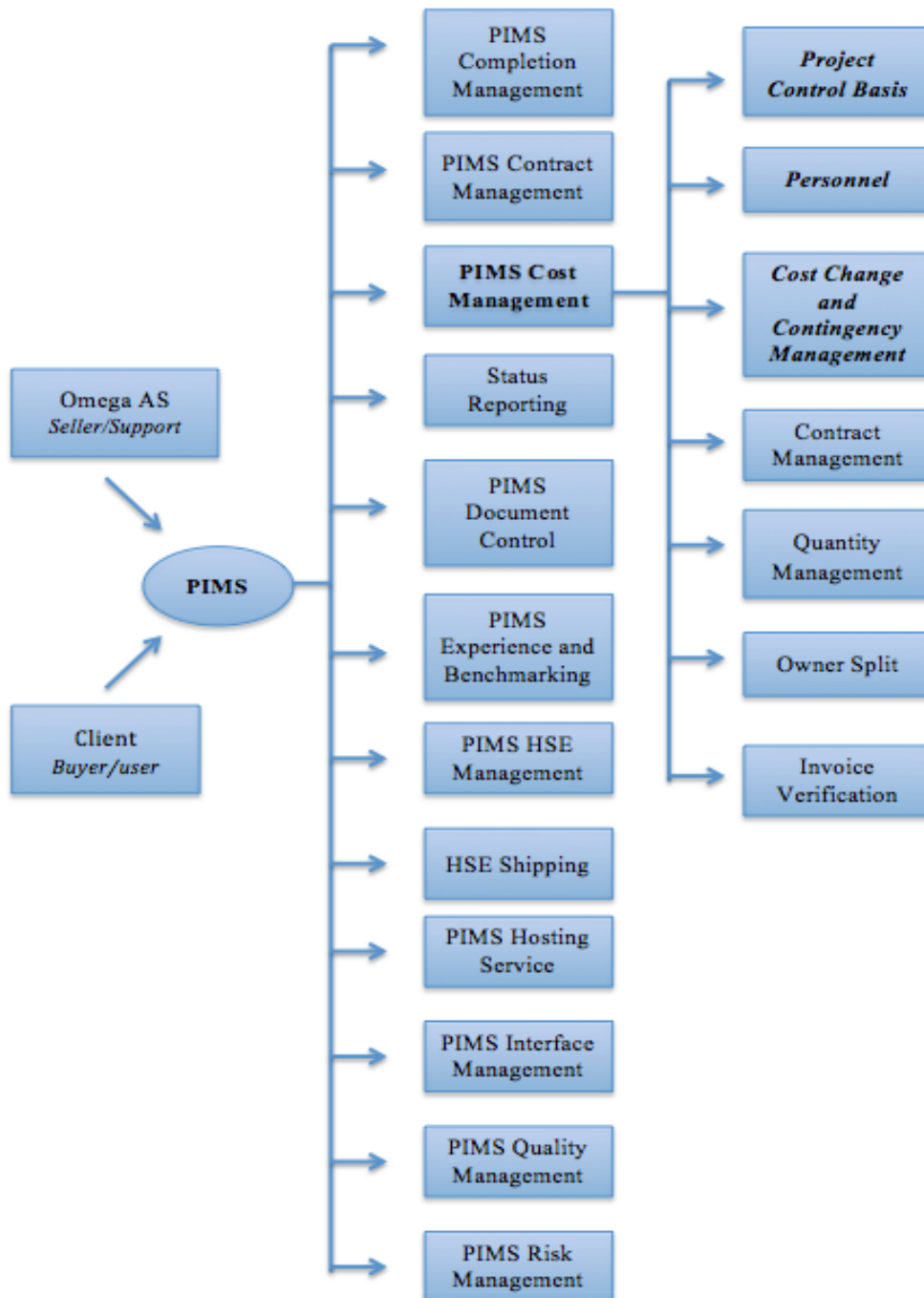


Figure 2.10: Overview of PIMS and PIMS Cost Management (Omega AS 2012)

As PIMS Cost Management consists of several features we will only give an explanation of the highlighted features from Figure 2.10. This is done to generate an understanding of how some of the features in the module could contribute to the process of cost management in complex projects. Features that are not highlighted are also important, but we consider the highlighted ones as more relevant in order to approach our research question.

Project Control Basis

The Project Control Basis (PCB) includes core features required to control the costs of the project such as developing a WBS, registering estimates, developing cost plans, managing baseline and executing monthly reporting.

Several functionalities are available in this module. An important functionality is the initial project setup, which refers to clarification of project start/finish, type of currency, cut off type and date, exchange rates, yearly inflations etc. Further on the PCB generates the possibility to develop the WBS for a project and identify work packages as well as enter the latest cost estimate data on each work package. These estimates would be used as a foundation when the system develops the baseline. Additional functionalities are available regarding baseline management such as performing baseline updates, establishing new baselines, activate and timephase new estimates and approve baseline. When the current baseline is approved one is able to do monthly status reporting based on updated information from the system regarding contracts, progress, actual expenditures and forecasts. An illustration of the monthly reporting process is illustrated in Figure 2.11 (Omega 2012).

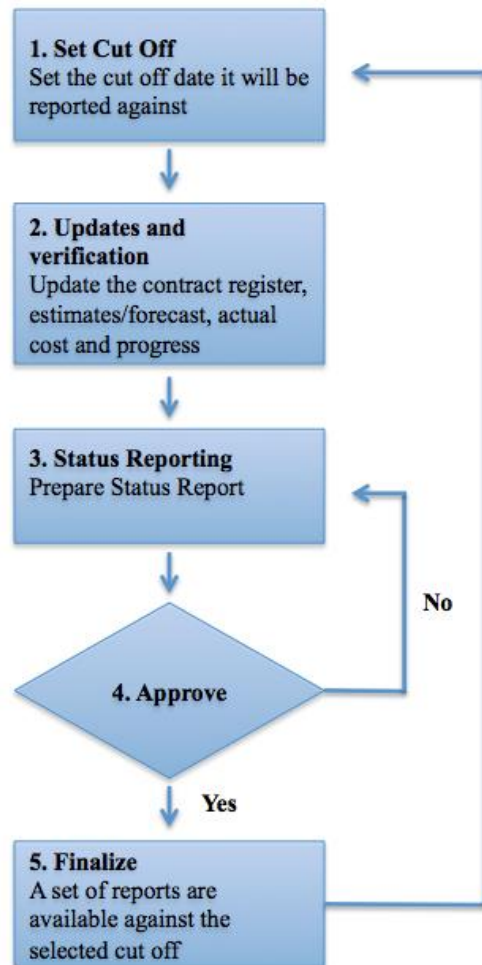


Figure 2.11: Monthly Reporting Process (Omega 2012)

Personnel

The feature of personnel is used to organize, allocate and estimate the personnel of a project. Following functionalities are included: defining resource requirements, the possibility to link personnel to the WBS to estimate man-hour cost and transferring these estimates to the PCB when performing a baseline update. As in previous features it is important to do the initial setup regarding position category, position type etc. Further on the system enables management of the position register by using functionalities like archiving positions, including finished positions and showing the personnel hierarchy. The personnel module also include the possibility to update the personnel cost and man-hours forecast by following a simple procedure illustrated in Figure 2.12 (Omega 2012).



Figure 2.12: Updating the personnel cost and man-hour forecast (Omega 2012)

Cost Change and Contingency Management

This module is supposed to identify, categorize and estimate changes as well as track and estimate the contingency drawdown. Once again, doing the initial setup is important which in this case refers to implementing information on the change regarding classification, what area it is tied to as well as available actions. Furthermore, the functionality regarding registration of a new change is available. This refers to registering the impact of the change on cost and schedule by relating it to a work package, as well as the ability to show the cost impact on the contracts. The latter is only available if one uses the functionality of relating the cost change to a contract cost element. As well as registering changes, this feature makes it possible to approve changes simply by clicking “approve”. Lastly there are functionalities regarding contingency, which refers to the ability of marking specific work packages as contingency work package and defining a planned contingency drawdown. This drawdown could be, either manually or automatically, developed by the system (Omega 2012).

2.6 Preliminary Summary

Theories on project control, PMIS, cost management in projects and the PIMS CMM have been presented. The aim is to understand how a PMIS could, in theory, generate various effects by focusing on the cost management processes.

After reviewing the theoretical part, some aspects on expected effects of using the PIMS CMM have been reflected. We believe that the PIMS CMM could simplify the process of gathering and sharing information at one place. This could result to a cheaper and a more efficient way to document information, as it only needs to be stored once. The system could also enable a company to store information concerning the management team as well as contracts, which indicate the systems flexibility to extract various types of information. When performing the cost management processes, we believe that the PIMS CMM could assist in a more accurate executed cost control. We imagine that processes are done more automatically in the CMM, as it includes more features compared with more simplified tools like spreadsheets. As the PIMS CMM includes the possibility to extract reports and continuously make changes this could indicate an increased performance of the project by using the system.

Based on the articles from Thomsen and Vik in section 2.3, we have chosen some of the effects that we believe could be expected by utilizing the PIMS CMM. These expected effects are presented based on the previously stated features of PIMS and are illustrated in Figure 2.13.

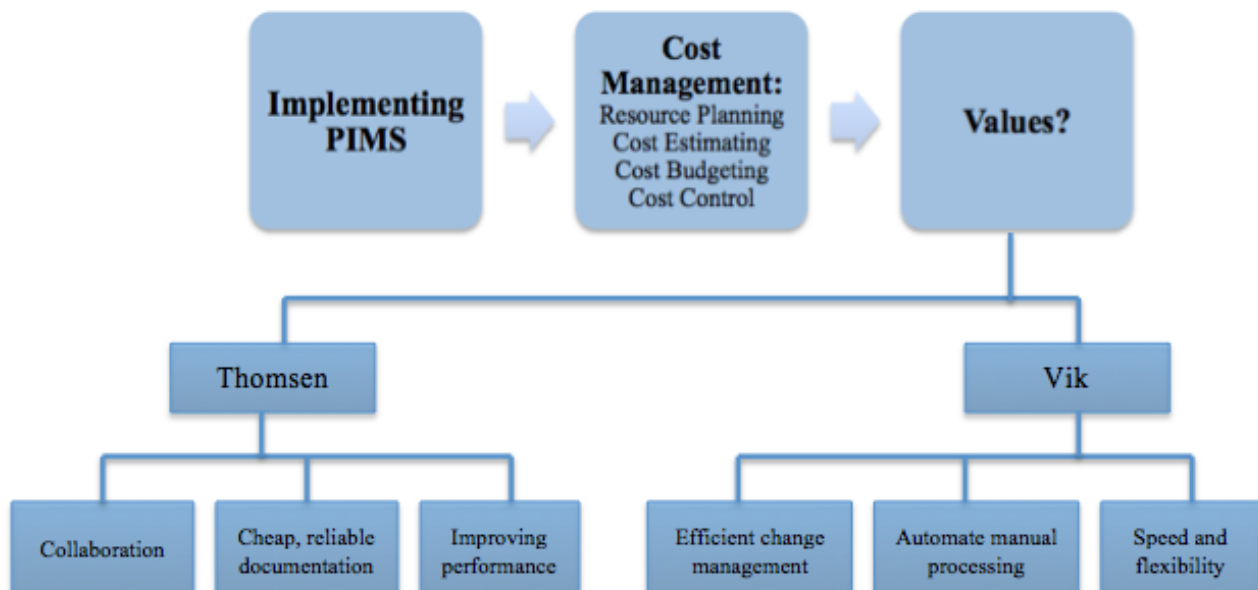
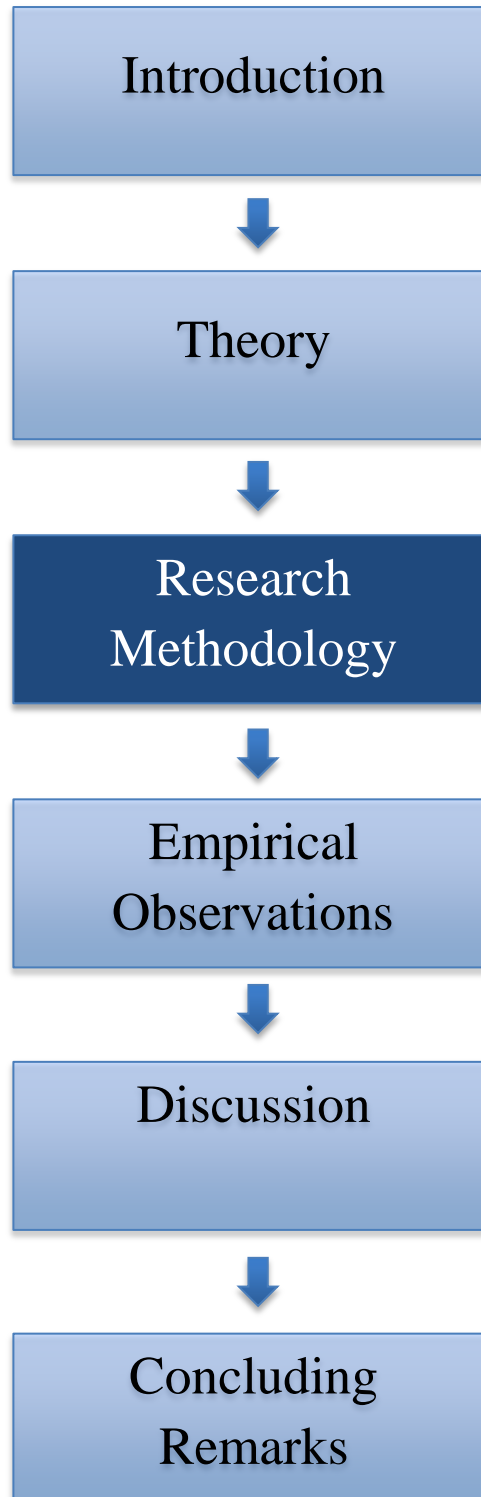


Figure 2.13: Expected values of utilizing the PIMS CMM

Chapter 3 – Research Methodology



3.0 Research methodology

This chapter focuses on how the research was conducted. First, the choice of research method is reviewed, followed by an explanation of how the empirical data was collected, and finally, how the data was analyzed.

3.1 Choice of method

How to conduct a research depends on the data needed for approaching the research question (Ghauri and Grønhaug 2005). Different types of methods exist, and the most common distinctions are between quantitative and qualitative research (Myers 2009). Quantitative research focuses on numerical measurement and is commonly used when wanting to study a topic across several people by using a large sample size to generalize to a large population. Qualitative research is used when the researcher want to discover and understand a particular subject in depth from a smaller sample with valuable information. The aim is then to discover true inner meanings and new insights. By using a qualitative approach one is less dependent on structure and the method gives the opportunity to gather empirical data by using visualizations and/or oral explanations. The key to successfully using either or both methods is to match the right approach to the right research context (Zikmund, Babin et al. 2010).

The main objective of this thesis was to answer the research question “*What are the effects of utilizing the PIMS Cost Management Module in complex projects?*” In order to identify the effects we had to generate insights from experienced individuals with knowledge about the use of the CMM. Because this was an unknown territory with no previous studies on effects of utilizing the PIMS CMM, our thesis was performed with a qualitative approach. This method was chosen as it enabled us to achieve a more deeply understanding of how the respondents used and interpreted the system. One of the key benefits with qualitative research was that it allowed us to be flexible and study a particular subject in depth in order to achieve the greatest insight (Myers 2009). However, a qualitative research is said to be more subjective as the results are research-dependent. Different researchers could therefore reach different conclusion on the same interview (Zikmund, Babin et al. 2010).

3.2 Sampling method and data collection

Myers (2009) describes an essential distinction between primary and secondary sources of data in the social science. Primary sources include unpublished data gathered directly from individuals or organizations by the researcher. Secondary sources involve data that have already been published such as books, newspapers and articles. The data collection of this thesis has been focused around primary data. The primary data were conducted during the interviews with the respondents, and a detailed description of this process follows.

3.2.1 In - depth interviews and the structure

For collecting the data there are different techniques used in qualitative research, such as fieldwork, interviews, using documents, etc. One of the most common techniques for data gathering in qualitative research is interviews (individual in-depth interview or focus group interview). As this technique allows the researcher to gather informative data from individuals we decided the approach of in-depth interviews as most suitable for our research. By carrying out in-depth interviews it could help us to understand people, their motivation and actions and the broader context within their experience considering the PIMS CMM (Myers 2009). Seidman (2013) states that an interview is a powerful tool where the researcher has the possibility to ask several questions about a topic to provide more insight from particular individuals. The role of the interviewer is therefore critical in terms of encouraging the respondent to talk freely without influencing the direction of the conversation (Zikmund, Babin et al. 2010).

Myers (2009) describes structured, unstructured and semi structured as the three basic types of interviews. Structured interviews consist of pre- formulated questions typically in a specific order and sometimes within a limited amount of time. Unstructured are the opposite of structured interviews where this type of interview consists of no, or very few, pre- formulated questions or topics. The most commonly used type of interview is semi structured interviews, which tries to make use of the best of both approaches. Since previous studies on effects of implementing a PMIS are somewhat limited, where our study can be considered as the first research focusing on the PIMS CMM, we found it natural to use semi structured question. This type was chosen because the approach generated some structure, but also freedom to improvise. It gave us the flexibility and the advantage of adapting questions to each participant to address necessary information, while still keeping focus with pre-formulated questions and topics

(Zikmund, Babin et al. 2010). We considered this structure to be highly relevant as we were interested in knowing each respondent's thoughts of using the CMM and how the system influenced their day at work. By using this structure we believed the interaction with the respondents was better and that it was natural to ask unstructured follow-up questions when necessary.

3.2.2 Interview guide

We composed an interview guide with the aim to detect various effects of using the CMM (Appendix 1-4). This guide was supposed to contribute to our research by structuring the elements that we wanted answers to. As our theory related to cost management is divided into four processes, we decided to make an identical distinction in the interview guide. This was done to be able to ask the respondents about how they worked with various cost management processes, and then use these answers in analysis to detect various effects. We believed this structure to be most appropriate to best answer our research question. Based on this we decided to relate several open questions to each cost management process. By asking open questions the ability to detect a greater range of effects was increased. This also enabled us to ask follow-up questions to probe for further explanations about the effects, as probing questions are critical through this process (Zikmund, Babin et al. 2010).

We decided to prepare two interview guides. The first one was developed for Omega, where the questions were presented in a way that enabled us to learn as much as possible about PIMS and the CMM. The aim was to use this information to compose even more precise questions to the companies, and to generate a broader understanding of the PIMS CMM. The second interview guide was composed for the companies/respondents. This guide contained, to some extent, revised questions in order to best answer our research question. We used our experience from the interview with Omega to be able to ask more precise questions and thereafter collect more throughout information concerning the effects.

We decided to begin the interview guide with an introduction of the purpose of the interview and some questions concerning background and work experience of the respondent. This was done as a warm up to create an open environment for conversation, and not a typical interview-respondent setting. By starting slow and comfortable we achieved a feeling on how the respondent would act and answer further questions. As the interview guide was divided into the

four cost management processes, we further decided to divide each process into two parts. These were representing questions related to the respondent's experience of using the CMM as well as the respondent's thoughts of not having the ability to use the CMM. This structure was done in order to create an understanding about the contribution of the CMM, and thereby be able to search for effects of using the system. At the end of the interview we included some questions about challenges and potential improvements with the CMM. This was done in order to detect experience related to complicated functionalities as well as possible changes to improve the CMM. To make sure that the interview guide was well formulated and understandable it was pre-tested and also confirmed by our supervisor.

3.2.3 Sampling design

Selecting respondents is of great importance when doing research because this process would influence the analyzing process. Not only is the process of selecting the respondents important, but also deciding the number of respondents to include in the research. According to Johannessen, Tufte et al. (2004), who and how many respondents that should be selected, depend on the research question. According to them, there are no limits on the number of respondents when doing interviews. However, the higher number of respondents included, the more work regarding time and effort will be needed.

When deciding on a suitable sampling design it is common to choose between probability sampling and non-probability sampling. In a probability sampling there is a nonzero probability of being selected attached to all members of the population. In a non-probability sampling the probability of each member being selected is unknown. There are various procedures for non-probability sampling such as convenience sampling, judgment sampling, quota sampling and snowball sampling. In our study we made use of judgment sampling, which means that we used an experienced individual to choose the sample based on a judgment about some required characteristics of the sample members (Zikmund, Babin et al. 2010).

The sample was collected with the help of an experienced family member who acted as our contact person throughout the whole process. Our contact person used personal judgment to select the sample units based on some predetermined criteria in order to approach our research question. These criteria were: that the sample units should be customers of Omega, working in an international oil and gas company, working with complex projects and have experience and knowledge with the PIMS CMM. Those specific criteria were selected based on the ability to

answer our research question as well as the availability of experienced respondents. Our contact person used his personal network to tie a connection to the relevant respondents both from his own company as well as a competitive company.

To search for effects of using the CMM we needed respondents who were frequently using the module and had an extensive experience with it, thus the choice of customers of Omega. As well, we limited our research towards complex projects in the oil and gas industry; simply because this is Omegas target customers where this group was expected to hold extensive knowledge and experience with the system. Additionally, our contact person had personal relations with several respondents in this industry which made it easier to collect a relevant sample. As a result, respondents from two different companies that represented customers of Omega were chosen. Due to strict restrictions regarding anonymity, there are limitations towards information that are allowed to provide about the companies. However, the companies were well known in the oil and gas industry, where one of them has several decades with experience in the industry while the other has less experience. The different level of experience was of importance because we thought various experience would generate different types of effects. They are both listed on the stock exchange, and the companies have recently been part of some of the largest oil discoveries on the Norwegian Continental Shelf. The companies are therefore known to work with complex projects both nationally and internationally. They possess highly qualified and experienced personnel and use the CMM in order to manage costs in most of their projects. Based on this, the companies with belonging respondents were believed to be qualified in order to best answer our research question.

3.2.4 The respondents

Based on the chosen sample design our contact person selected in total eight respondents for in-depth interviews. These respondents fulfilled the predetermined criteria and were believed to contribute to our research. Two of the respondents were representing Omega and six were representing the customers of Omega. We decided to include such a small sample of the population of Omegas customers due to the time limit of our thesis. However, the respondents were selected based on a thought that they would possess a high amount of relevant information concerning the CMM. It was considered that customers of Omega with experience of using the CMM could contribute with valuable information to search for the effects of using

the system. In addition, Omega themselves were believed to provide us with a general understanding and description of the functionalities included in the CMM.

In order to keep the companies and respondents anonymous we decided to categorize them in two main groups, presented as Company 1 and Company 2 (Table 3.1). The respondents were further categorized with numbers where Company 1 was represented with X and Company 2 with Y. All the respondents had worked with complex projects and PIMS, but the position, number of years working in the company and experience with PIMS differed. Among the respondents two were female and six were male, where the positions varied from cost controller to project control leader. From Company 1, several of the respondents had several years in the company and experience with PIMS, where one of the respondents had worked with the system for over 20 years. Most of the respondents from Company 1 therefore knew the system well. Respondents from Company 2 had however less experience and years in the company. One of the respondents had some experience with both the company and PIMS, while the other respondent from the company had more extensive experience with the system. More detailed information was not allowed on behalf of strict restrictions regarding anonymity.

Table 3. 1: The respondents

Company	Respondents	Number of years in the company	Number of years working with PIMS
Company 1	X1	30 years	20 (+) years
	X2	30 years	18 years
	X3	14 years	10 (+) years
	X4	7 years	4 years
Company 2	Y1	7 (+) years	13 years
	Y2	5 years	5 years

3.2.5 The interview setting

We had a close correspondence with our contact person throughout the process, who informed us about the selected respondents. Our first interview was with Omega, where time and place was arranged through telephone. The interview was done in their main office in a meeting room with both of the respondents presented simultaneously. Concerning the interviews with one of Omegas customers, our contact person organized and informed us about the appointment time, date and place. These interviews were held at the company's main office in a meeting room. The interview with the other customer of Omega was arranged by our self, where we made

appointments on when and where to meet, together with a short description of our research through e-mail. This interview was also held at their office in a meeting room where both respondents were present.

The empirical data was gathered through face- to- face interviews with all the respondents. As previously stated, most of the interviews were done with only one respondent present, but two of the interviews were conducted with two respondents present at the same time. This solution was chosen due to the respondents wish, but it also resulted to an interesting discussion between them and us. However, a concern related to this could be that the respondents held back on certain information to prevent a discussion with the other respondent.

We wanted to create an environment for conversation during the interviews, and the setting was therefore informal in order to encourage the participants to talk open and freely. We asked for permission to record all interviews, as this would simplify the transcribing process by making sure we got answers to all our questions, as well as a greater understanding. All of the respondents accepted the use of the recorder and we did not perceive that the use of the recorder made the respondents uncomfortable with answering the questions. However, the possibility that they may have excluded some information or points needs to be considered.

Through our first interview we learned that not all questions were as relevant as we thought, and we revised some of the questions accordingly for the following interviews. However, we experienced that most of our questions created the conversation we were aiming for. We decided to discuss the interviews immediately after they were conducted in order to summarize and come across new topics or formulations before the next interview. This was a great benefit as we then was able to get even more precise reflections to answer our research question.

An important point to mention is that all the interviews were conducted and written in Norwegian before transcribed to English afterwards. We considered this as a suitable decision based on all of the respondents, including us, having Norwegian as the native language. As a result, explanations and phrases could more easily be expressed and understood during the interview setting. However, it must be taken into consideration that information may have been misunderstood. Due to cultural differences, expressions and phrases could lose their actual meaning.

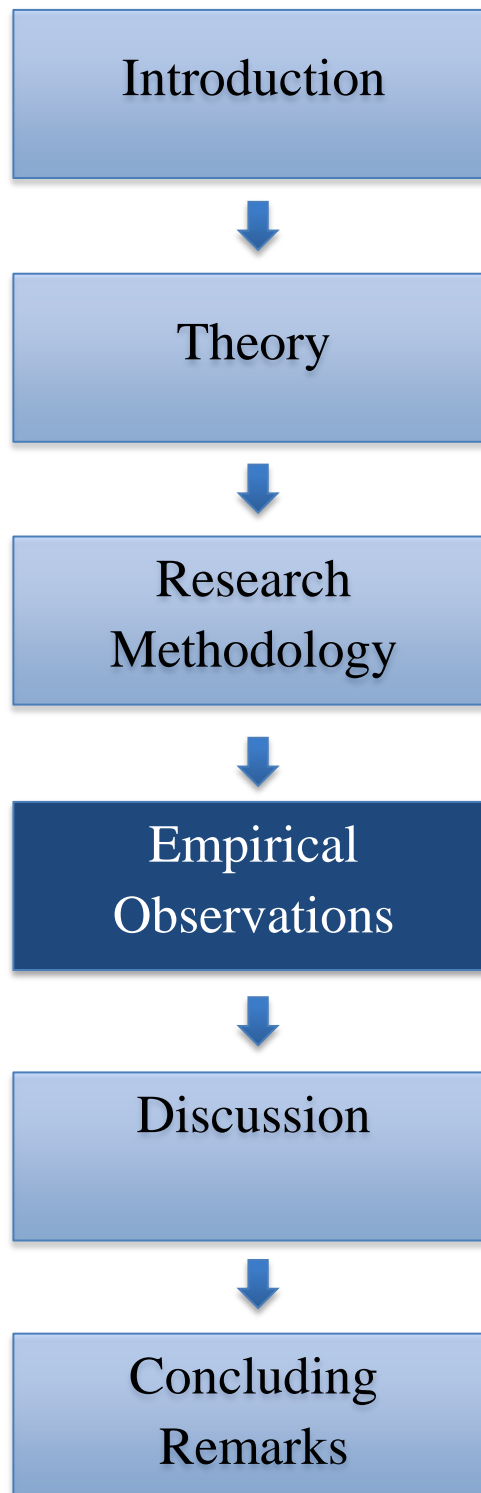
3.3 Data Analysis

The empirical data in our thesis was gathered through the previously discussed in-depth interviews. When all relevant raw data had been collected, we focused on transcribing the important elements from the interviews. Less important information was excluded due to the fact that some tedious oral explanations and phrases could be insignificant. The process of transcribing raw data could be time-consuming, but the result is generally more accurate and detailed information (Jacobsen 2005). We also decided to use several sentences and explanations quoted from the interviews in our research. This was done to generate a broader meaning to some of the elements as well as making the empirical observations more interesting for the reader. Quotes also made it easier to reveal the meaning of a statement.

According to Johannessen, Tufte et al. (2004) the core of qualitative analysis is to make sense of a large amount of unstructured data, reduce the information amount, identify pattern and to make a framework to communicate the context. After making sure that the transcribed data represented the information that emerged from the interviews, it was important to use time to generate the true meaning of the information. We used a great amount of time to structure and organize the empirical data to be able to present the data in a suitable manner. This was done to reduce the amount of information in order to analyze the data more efficiently. Based on the theory, we therefore decided to organize the empirical observations into the four different cost management processes, where relevant and explanatory quotes were attached when suited. Each process was presented with the observations from the respondent's use of the PIMS CMM as well as the respondent's thoughts of not using the PIMS CMM.

When the empirical observations were structured and categorized the process of presenting them was straightforward. By using such a great amount of time to organize the observations, the process of analyzing and discussing was simplified. We perceived some of the results to be more important than others. When analyzing the empirical data we therefore decided to categorize and present them in suitable categories representing relevant effects from the research. The effects extracted from the research were further analyzed and discussed in order to detect how the respondent's use of the CMM in cost management could create effects, both positive and negative.

Chapter 4 – Empirical Observations



4.0 Empirical observations

In this chapter the data from the interviews will be presented. The data are divided into categories based on the interview guide and are presented in the following order: resource planning, cost estimating, cost budgeting and cost control. The goal of this chapter is to highlight how the PIMS CMM could be a contributor in managing costs in complex projects. We have decided to include all of the four cost management processes, even though the PIMS CMM is mainly concerned with cost budgeting and cost control.

The empirical data are based on in- depth interviews with Omega and their customers. As previously stated the customers will be presented anonymously in order to secure the respondents anonymity. The observations will therefore be presented and related to one of the companies and/or the respondent's identification letter as presented in the research methodology (Table 3.1).

The empirical data will be presented with a structure aimed to simplify the reading process. Each cost management process will first be presented with empirical data from the interviews with Omega. This is done to generate knowledge towards the system's ability to contribute in each process, expressed by experienced personnel from Omega. Further, the empirical data from the customers will be presented, where each cost management process is divided into: the respondents use of the PIMS CMM and the respondents thoughts of not using the PIMS CMM. This will be the throughout structure concerning each cost management process in order to best answer our research question.

4.1 Resource planning

The PIMS CMM does not include all functionalities concerning resource planning because developing a standard product based on various working methods is difficult. Omega mainly delivers solutions to Operators, and PIMS is therefore considered as a tool to assist them. As a result, the system is not used for resource planning towards contractors, but towards the internal management team of the project organization. The PIMS CMM has a simplified function called the Management Personnel Plan (MPP) which makes it possible to estimate the total cost of the management team based on type of positions, expected duration and expected rates. Based on

this, the system calculates an estimate of the management team. Estimating the cost of the management team could also be done based on previous experience.

In the future, Omega expressed a desire to develop a more complete planning module. However, they have some difficulties with determining what to include in terms of dependencies between activities. Usually their customers use Safran, Prima Vera and other specialized planning tools in resource planning before importing this information into the PIMS CMM. However, in order to satisfy demands, customized planning solutions have been made, but these are not standard products. In addition, a function called CTR has been made which concerns planned Costs, Time and Resources.

4.1.1 The respondents use of the PIMS CMM

When we asked the respondents how the PIMS CMM could contribute in the process of resource planning there was a mutual respond that resource planning was not its main functionality. Several respondents expressed that PIMS are developed towards Operators, and that resource planning regarding materials, equipment etc. are more in the hands of potential contractors. The respondent's use of the system regarding resource planning was therefore concentrated on the MPP function, where the level of experience varied between the respondents. Respondent Y1 explained a limited use of the MPP function because of less experienced employees in terms of application of the function. However, in the future they wanted a more extensive use of the function.

"We are going to use the MPP function gradually when it becomes more relevant". (Y1)

Other respondents expressed a higher degree of use considering the MPP function seen in the context of a criterion to use it in all projects within the company.

"PIMS have a function considering personnel which are used in internal planning in the company. This is a suitable tool with good structure where one is able to enter various categories of personnel in order to sort the workforce." (X1)

“Personnel are located in the PIMS CMM with respective start/end dates and rates of resources to make an estimate. Must ensure that it is constantly updated so that it can be used in a forecast when we report status. This is clearly an important function in order to execute cost control. This module enables us to keep track of the expected management fees”. (X2)

Some respondents explained an additional need to use Excel spreadsheets if several projects were taking place simultaneously. Because the MPP function only illustrates the total percentage on each employee, spreadsheets were used in order to structure the distributed percentages between the projects. Some respondents therefore expressed the possibility of a more complete planning function in PIMS, especially in cases with several projects.

“The MPP function works fine, but it would have been better if everything was included in PIMS in order to prevent summation errors”. (X3)

When we asked if there was a need for a more complete planning function in the CMM, one respondent clearly expressed no. The reason was explained to be because PIMS is a database and is not supposed to be used extensively in resource planning. Both of the companies were using the additional planning tool Safran consisting of a plan showing hours and resources of various activities. Safran were explained to be a more specialized planning tool consisting of, among other functions, dependencies between the activities (network planning).

On the other hand, some expressed the possibility of an extensive use of PIMS in planning if the system was good enough.

“If PIMS included a more complete planning function we would probably have used this. Then as a separate module.” (X4)

4.1.2 The respondents thoughts of not using the PIMS CMM

When asking the respondents how they would perform resource planning regarding personnel without a system like the PIMS CMM, most of the respondents emphasized that they would have used Excel spreadsheets.

“I have experience with large excel sheets. It is fine as long as the spreadsheets works, but usually you get very dependent on the persons who have carried out the sheets”. (X4)

Some respondents discussed the challenge of using Excel spreadsheets as a replacement for the PIMS CMM. Some challenges that was mentioned was the workload to develop structured sheets, the risk of making formula errors and the challenge of generating a more realistic allocation of the resources by taking into account holidays etc.

“Without PIMS one usually use Excel spreadsheets, however this is more work demanding. All the changes are more difficult to implement. PIMS CMM has a more correct distribution than excel because it takes into account holidays”. (X2)

It was also revealed the disadvantage of having a less uniform implementation with Excel spreadsheets, especially when exchanging between projects. In addition there was stated that Excel spreadsheets could generate an overall lower quality and a more poorly visualization as well as being a less standardized process.

“With Excel it is less standardized because it is harder to know how to proceed”. (X4)

4.2 Cost Estimating

The PIMS CMM does not include all functionalities concerning the process of cost estimating. This is due to the fact that cost estimating is generally done outside of PIMS before the estimates are implemented into the system. When the cost estimation is done, the estimates need to be linked to the belonging work packages (which are the lowest WBS level in PIMS). Further one need to decide if the individual work packages are measurable or not. Direct costs (material and labor) are measurable whilst management and other indirect costs are normally non-measurable. The functionality to relate estimates and work packages makes it possible to generate a view of the total cost as well as the more detailed cost elements on each work package.

When inserting the estimates into the system one categorize them as either A, B, C or D estimates. This is done in order to separate the estimates regarding level of detail, where D estimates holds a higher level of detail. Estimates categorized as D are generally used in the execution phase.

The direct cost estimates inserted in the system have a price and an installation cost attached to them. Thereafter, PIMS can be used to calculate indirect costs (engineering and management) to generate an estimate. This process varies between companies, where some companies estimate all details in-house whilst other requires parts of the estimates to be dependent upon awarded contracts. PIMS handle both methodologies.

In addition to the CMM there exists a module called Experience. This module enables companies to gather and structure experience data. These data can then be used to benchmark the cost estimates.

4.2.1 The respondents use of the PIMS CMM

Even though cost estimating is done outside of the CMM, the respondents had some comments on the implementation into the system and various functionalities used in the process of cost estimating.

Respondents from Company 1 commented on how the estimates were inserted into the CMM. They explained how the estimates were presented on spreadsheets from the estimating department and the vendors before they were implemented into the system. The estimates had to be transferred manually into PIMS when establishing the project.

“The estimating departments present the estimates on an Excel spreadsheet. These estimates are then manually transferred into the CMM when establishing the project.” (X2)

“The current situation is that the estimates are being prepared in a specialized estimation tool outside of the CMM. The estimates are then being transferred to Excel spreadsheets before manually transferred into PIMS.” (X4)

Respondent X3 explained how the estimates got inserted into the CMM based on a predetermined structure. This structure did not always tie in with the contract structure. It could therefore be an extensive task to align these two structures. As a result some estimates occasionally needed to be split while others needed to be merged. However, the process of implementing the estimates into PIMS was not experienced as difficult, but it had to be done manually.

“The implementation is not difficult as long as the estimates are developed according to the work package structure. The implementation process has to be done manually.” (X3)

In Company 2, both of the respondents expressed a frustration regarding the implementation process of the estimates. They commented that the estimates are based on quantity and units, whilst this is not reflected in the CMM.

“PIMS only present a single number, but what is this number? This number does not tell me anything! PIMS generate a limited amount of information. How is it possible to execute cost control without all the information (quantity and unit) from the estimates?” (Y1, Y2)

Another discussed challenge was regarding the level of the WBS, where PIMS had a more aggregated level than the estimating department. Because of this, implementing the estimates into PIMS could sometimes be seen as difficult.

“This is not a simple transfer, we have to look back at the foundation that is not presented in PIMS (because PIMS presents on a higher level).”(X2)

A major part of the respondent expressed a satisfaction towards the foreign currency function in PIMS. This function was used when receiving invoices from vendors. By implementing the exact amount and currency from the invoice, the system automatically calculated the correct amount on behalf of predetermined exchange rates.

“PIMS use predetermined exchange rates, while the invoice is presented with the rate of the day. In this case we use the currency function to collocate these.” (X3)

“...being so that PIMS has a currency function to take care of this automatically is very good.” (Y1)

Some respondents discussed the possibility of using PIMS to extract experience-based numbers. These numbers could be forwarded to the estimating department and further used to update data and provide more precision in their estimates (Experience module).

“The historical information in PIMS is good. You know that the numbers are correct and that they are not possible to change when they are locked.” (Y1)

4.2.2 The respondents thoughts of not using the CMM

Because the process of cost estimating is done outside of the CMM, it became difficult to extract empirical observations from not using the system. However, one respondent expressed a concern regarding not having access to the currency functionality in PIMS. The process of calculating the correct amount on each currency was then explained to become difficult.

“When getting variable exchange rates it can quickly become messy if this is not done correctly.” (Y2)

By not having the possibility to insert the cost estimates into a system like PIMS, some respondents expressed a concern regarding further processes. They explained how a consequence could be a more comprehensive process with monitoring and controlling.

“...would be difficult to do the current work on Excel spreadsheets... could not have performed such an extensive reporting as we do today.” (X2)

Some respondents emphasized the possibility of a more complete CMM regarding the different processes. In the current situation both companies were using additional tools to assist in various processes, especially in cost estimating. The reason was explained to be the flexibility and the degree of specialization by these tools, as well as requests from the management. Several respondents expressed how the management requested specific numbers and calculations on spreadsheets, and not by using PIMS.

“It would have been nice if PIMS was more complete than it is at the current situation. One has to punch a lot of numbers manually. I think the reason is because the management requests certain calculations on spreadsheets...if one were able to explain to the management the possibilities that exist in PIMS I think we could have used the system more extensively” (X3)

“...this is closely related to specific calculations requested by the management...some numbers and calculations the management do not want or do not understand.” (Y2)

4.3 Cost Budgeting

As previously stated the CMM is mainly concerned with cost budgeting and cost control, but there are challenges when separating these two processes as they are closely linked together. The processes will be presented separately, but there is a possibility that some functions are concerned with both processes, even if they are only presented in one of them.

A system like PIMS is more focused on the future and not the past like an accounting system. The process of cost budgeting in PIMS is thus a forward-looking process by making predictions about the remaining cost. PIMS include a function where one is able to automatically transfer recorded costs from the accounting system (such as SAP) into PIMS. In addition, the estimated costs need to be manually inserted into the system. A commonly used functionality in the PIMS CMM is the possibility to timephase costs and developing budgets. This refers to the systems possibility to, either manually or automatically, timephase costs monthly. These costs can further be analyzed and evaluated, but this will be presented more closely within the process of cost control.

4.3.1 The respondents use of the CMM

When we asked the respondents about how the PIMS CMM could contribute in the process of cost budgeting, a respondent from Company 1 stated that this is a well suitable tool for this purpose. The respondent explained some of the preparations that needed to be done before inserting the estimated costs into the CMM to use the timephasing functionality. Excel spreadsheet was a commonly used tool to structure information by doing additional calculations before inserting the estimated costs into the PIMS CMM. To be able to timephase one needed to know if the work packages were measurable or non- measurable. In case of measurable work packages the company received a monthly progress/consumption of time, which was used in the process of timephasing costs monthly. The PIMS CMM was explained to be of major help and to generate a great overview in the process of cost budgeting.

“I use Excel spreadsheets to structure information concerning the baseline. Planned activities and monthly consumption of time are used in order to allocate costs on a monthly basis. I use Excel spreadsheets to do various calculations before I implement the estimated costs into PIMS and timephase. It take some time to prepare for a baseline, however PIMS give a good overview when it is done.” (X2)

Other respondents also commented on the possibility of using the system to timephase the estimated costs, and thus developing budgets. They explained how they were timephasing the estimated costs monthly based on planned progress of the activities received from the planning department. This could further be used as a foundation in the baseline update that took place every sixth month. When updating the estimates at every baseline, the outcome was updated timephased costs and updated budgets. This was used, at every baseline, to present the updated total cost of the project to the management. The respondents expressed this process to be clear and structured, and how PIMS were a flexible and updated system.

“We provide input to the budget by timephasing the costs at every baseline update. The process of timephasing is not done every month, but every sixth month.” (X4)

“Imagine that you have composed a WBS and prepared a cost plan with timephased costs. Concerning the baseline update, you will have to update the plans before getting new timephased costs and new budgets. A budget is only next year, but it is possible to timephase for several years. PIMS is a very updated and flexible system when it comes to this process.” (X1)

“At every baseline update we have a presentation towards the management. By using PIMS we can present last month total cost and current month total cost. This is timephased and we use this as a budget document.” (X2)

4.3.2 The respondents thoughts of not using the CMM

By not using the CMM, most of the respondents agreed that it would be possible to use only Excel spreadsheets. However, they expressed some challenges that could be expected. Some challenges were how it could make the organization more vulnerable concerning individual dependency, how it could be more time consuming and how it could result in a lower quality.

“Most things are possible with Excel spreadsheets. The problem is that you generally start small and things go well, but when the spreadsheets expand you get very dependent on the person behind it. It is then impossible for others to manage.” (Y1)

“It would be more work when you have many activities and need to do the process of timephasing in Excel... PIMS is more organized and well-arranged. By using a tool like Excel I think we would use more time and present less quality of the final result. PIMS increase the efficiency of the process” (X2)

“I would have used more time. By using Excel there exist a higher risk to forget or lose important information, and it can be a challenge to undertake other peoples spreadsheets if you are not familiar with it”.
(X3)

The consequence of reduced quality was especially discussed by one respondent. The respondent explained that there would be less quality control by not using PIMS, and how it would require a greater amount of time to produce a result with the same quality. However, this amount of time was rarely available.

“...you would lose the quality control that PIMS offers, and therefore the quality would have been reduced. If you had plenty of time you could get the same quality, but you do not have this time. It is a lot more efficient with PIMS. In major projects it would be costly without a system like PIMS.” (X1)

A minority of the respondents had experience with only using spreadsheets. One respondent expressed the situation to be fine, but somewhat chaotic with a lot of spreadsheets. By using spreadsheets one got easily vulnerable concerning formula- and summation errors.

“Excel has constructed spreadsheets, but they are very locked by not having the ability to identify all the macros behind them”. (X4)

4.4 Cost Control

The process of cost control in the PIMS CMM is mainly concerned with collecting, analyzing and updating relevant information in order to report status on the project. As previously stated, some companies use additional tools in several processes of cost management. However, the output from these previous processes is implemented into PIMS in order to execute cost control and prepare structured reports.

When using the PIMS CMM to report project status, it is important to have access to accurate cost information. Some costs need to be manually inserted into the CMM whilst others are entered automatically. Recorded costs could be automatically transferred between the accounting system and PIMS while actual costs are usually manually inserted. However, the process of inserting actual costs differs between companies. Some companies extract recorded costs from the accounting system to perform further analyzes in order to prepare and implement actual costs. Other companies directly implement the actual costs received from contractors.

The CMM includes the possibility to calculate values and indices such as earned value, CPI and SPI. These values and indices could further be used to analyze progress and prepare forecasts. The cost engineer has a responsibility to make a decision based on these values to evaluate if the previous forecast needs to be revised. A forecast is typically done every month, and can be illustrated graphically in the CMM.

An important part of cost control is change management. There is a possibility to automatically include changes in the CMM, but this is rarely used. The reason could be that the specific change is already considered in the estimate, and should therefore not affect the forecast. Some companies perform change management directly in PIMS whilst others use spreadsheets before inserting the change. In addition, it is important to consider contingency. Contingency is presented as a percentage, and is gradually reduced throughout the project. Some companies have contingency related to each work package while others have a total contingency for the project.

By using a centralized database such as PIMS the information is shared out to various parties as early as possible. An accurate picture of the present situation is possible by focusing on costs when they actually occur and not wait on receiving the invoice. Potential changes (or if the contractor has a desire to change) and potential risks should as well be considered in order to

predict where the project ends at any time. Based on this, one is able to constantly provide information to all parties about the total project cost.

An important part of the centralized database in PIMS is that it is possible to generate various types of report by using various types of information. PIMS include, among others, a standard monthly report, which consist of a collection of several individual reports contained in PIMS. The system also has the ability to compose various other reports, as well as pivot tables.

4.4.1 The respondents use of the CMM

When we asked the respondents how the PIMS CMM could contribute in the process of cost control, there was a common agreement that this process were its main functionality. By having information and costs concerning the project structured and accessible in one system, it could be of assistance when forecasting and making reports.

4.4.1.1 The process of implementing actual costs

In order to develop an accurate forecast and report project status one need to have access to both the estimated and actual costs. A respondent emphasized how they request the contractors to monthly report actual costs. They explained the process where they received actual costs and progress from each contractor on the relevant work package, before this was inserted into the CMM.

“We ask the contractors to monthly report the actual costs to get a correct picture...the deviation should not be huge, but this is done in order to include it in our monthly report.”(X2)

Some respondents also commented on the importance of the currency function in PIMS. This was explained to be a well suitable function to detect potential deviations between recorded costs and actual costs, caused by different exchange rates.

“PIMS use predetermined exchange rates while invoices are presented in current rates. The currency function is then used to compare the rates to verify if they are higher or lower than expected.” (X3)

Several respondents commented on a potential improvement concerning the implementation of actual costs into PIMS. This process was explained to be time consuming where the respondents had to manually insert the actual cost to belonging contracts. In the case of numerous contracts this could be a time consuming task. Some of the respondents expressed a desire towards a more simple transfer to decrease the workload.

“When transferring actual cost to contracts you have to transfer one by one. This could have been an easier process.” (X3)

“...a bit too much back and forth. This could have been an easier process. It makes the process of monthly reporting time-consuming.” (X4)

“You do not get actual costs transferred by a simple keystroke, this has to be done manually...with numerous work packages this becomes a comprehensive task.” (X2)

4.4.1.2 The process of forecasting

Forecasting was a frequently mentioned topic in the process of cost control. The majority of the respondents explained how they extracted information from the database in order to prepare a forecast. Some of the respondents also revealed that a high amount of work concerning forecasting was done on spreadsheets before inserted into the system.

“The important thing is to be able to develop a forecast that we believe in, more precisely what the total cost of the project will be. PIMS does not give me an answer, but I use the information in order to organize and summarize towards an accurate forecast”. (X2)

“The information and data needed for the forecast is usually extracted from PIMS...while the work related to analyzes and forecasts are usually done outside of PIMS in Excel...” (X4)

Earned value was also mentioned when the respondents discussed forecasting. This value is automatically calculated in the CMM and indicates the amount of costs spent in relation to progress. A majority of the respondents expressed how they used earned value when forecasting. One respondent also expressed how one could use PIMS to trend a possible over - consumption over time to prevent a higher forecast.

“I sometimes use the earned value when forecasting. PIMS calculates earned value compared to progress. I would not have managed to calculate this on my own by using Excel”. (X3)

“I sometimes include the earned value in the forecasts... the value needs to be taken into consideration when forecasting”. (X2)

“If the actual cost exceeds the earned value there is an over -consumption. It is possible to use PIMS to trend this over time to illustrate the development of the cost and the following end result. If you do not change this tendency by making corrective actions there are a possibility of over - consumption and hence a higher forecast.” (X1)

The CMM also has the ability to calculate and illustrate indices such as CPI and SPI. When we asked the respondents if they made use of these indices there was a uniform response that they were not frequently used. Respondents from Company 1 mentioned that they occasionally used the indices in their evaluation when forecasting, but that they were not frequently used.

“I sometimes use the CPI, but not often.” (X2)

Respondents from Company 2 also explained a limited use of the calculated indices. However, based on previous experience they expressed a desire to a more extensive use to be able to detect errors on an earlier stage.

“We should probably have used some of the indices more as we then could have detected errors sooner. In one project we did not discover that something were wrong before just now, although PIMS gave a warning signal already in November. By being more focused on these functionalities in PIMS we could have detected this earlier.” (Y1)

4.4.1.3 The change module and contingency

Some of the respondents from Company 1 discussed the change functionality in PIMS.

Respondent X2 explained how they used the change function to describe and estimate changes, and that it was sometimes necessary to include the experience of the estimating department to make an accurate change. Respondent X1 made a more throughout explanation concerning the formal approval of these changes. Changes were approved in relation to an authority matrix. Generally the project manager was given the authority, but there was a possibility to delegate responsibility further down. Normally, a change towards the scope of the project had to be approved by someone with a higher position. The respondent explained how the change was inserted into the system to generate an updated cost estimate (original estimate + change). Every sixth month there were performed an update on remaining costs, where changes were included before updating the total cost.

“Change control could have an impact on total cost...we describe the change and make an estimate...sometimes dependent on expertise from the estimating department.” (X2)

“...you include the changes at all times, but it is only possible to update the control basis every sixth month at baseline. This means that you keep a record of the changes, and include them every sixth month in the total cost in order to update control basis, cost plans, budgets etc.” (X1)

Respondents from Company 2 also commented on the change module in PIMS. They explained the distinction between a project change and a contract change. A project change should practically be implemented into the contracts. Further, the respondents explained the process where a change usually started in the change module in PIMS and ended up as a contract change. There was a possibility to automatically relate these changes, but it required a high level of detailed knowledge.

...separate between project change and contract change. A project change should in practice be implemented into the contracts. We have a good picture on how this is to be done, but are not there yet. We usually start out with a change in the change module that would end up as a contract change. There exists a possibility to connect these changes. This is detailed and one needs a lot of knowledge on how things are connected to be able to use it.” (Y1, Y2)

Working with contingency was also discussed by some of the respondents. The calculation of contingency was explained to be based on the percentage of remaining cost, and was supposed to reflect the uncertainty of the project. The respondents explained how they used PIMS to identify uncertainties and opportunities. This was further updated monthly where one was able to make corrective actions. Since contingency is supposed to reflect the uncertainty of the project, one used the uncertainty as a basis to be able to update the contingency. This was supposed to be done monthly. If there had been any major risk movements the contingency was updated, if not it stayed the same.

“...in the WBS we have a work package called contingency. You make an evaluation of the contingency every month...the uncertainties and opportunities are used to identify the updates of the contingency, as this is supposed to reflect the uncertainty in the project...if there have been any major movements on the risk the contingency will be updated, if not the contingency stay the same.” (X1)

“...contingency are calculated based on remaining cost...can experience some problems at the end of a project if we have a high risk and a small amount of contingency left.” (X3)

4.4.1.4 Centralized database and reports

When discussing the process of cost control a majority of the respondents stated that they gathered useful information from the centralized database in PIMS. The database made it possible to look back on previous changes in order to know why they were executed. Important information needed for a forecast could easily be extracted from the database.

“The database in PIMS is satisfying. The system store comments and appendixes, which makes it possible to look back if necessary.” (Y1)

“By having the database it is possible to find the information you need for making forecasts. In addition, one can trust the information in PIMS to be correct” (X4)

One respondent emphasized that the CMM made information more available and structured. By having an easy access to information it became easier to collect relevant information to do various analyses, such as trending.

“...analysis are one of the advantages with PIMS, the numbers are more available. PIMS contribute to management information and the possibility of trending, which makes it possible to hold the information at an earlier phase.” (X1)

The same respondent commented on the possibility of retrieving historical information. The respondent had experience with loss of historical information in case of system update, and explained a need to store previous information on PDF-files. The same respondent commented how PIMS contained a high level of standardized processes. The respondent highlighted the

mistake of accepting the information from the system no matter what, and expressed that one should only use the information to do individual evaluations.

“I have experience from a case where we wanted to retrieve historical information from previous projects. This was hard due to the fact that the system was updated and the information was lost. Even so, storage of historical information is not the purpose of PIMS. PIMS is a forward looking tool and are not supposed to look backwards.” (X1)

“Yes, PIMS is very standardized. You can never use information from PIMS to conclude with a result, but use it in your own evaluations.” (X1)

Respondents from Company 1 explained how they, every month, arranged a meeting with the management team concerning the forecast. The meeting was focused on the project status and expected total cost of the project, as well as a presentation of why these numbers were represented. This information was usually presented in the monthly report from PIMS. Several respondents stated that by using the monthly report from PIMS, it contributed to a joint working method. In addition, they explained that the standardized monthly report covered several areas of the project, and that there were a possibility of using additional simple reports and Excel pivots.

“We issue a monthly report containing the forecast and project status. This includes planned costs, actual costs and progress. This is collected directly from PIMS.” (X2)

“We use the standardized reports in PIMS in our monthly reporting. In addition we use simple standardized reports as well as Excel pivots. The Excel pivots are a more flexible tool because of the opportunity to make various changes concerning columns etc.” (Y1, Y2)

“The possibility to extract standard reports from PIMS is good. The reports present both the progress, actual cost and the forecast compared to the project last baseline.” (X3)

Some of the respondents expressed a dissatisfaction related to transferring reports from PIMS to an Excel spreadsheet. Problems concerning transfer of formulas and summations and issues regarding additional rows and columns were mentioned. As a result, a lot of time had to be used to make the corrections as well as the possibility to make mistakes when working with comprehensive reports.

“From PIMS to Excel the formulas are not transferred. It would have been a great advantage if there was a possibility to include the formulas when making the transfer. Duplication of work could then been avoided as well as possible errors. In a hectic day at work it is easy to make mistakes when the summations need to be done manually in Excel. ” (X2)

4.4.2 The respondents thoughts of not using the CMM

Most of the respondents expressed that without PIMS they would have needed a similar system, or used Excel spreadsheets. By using spreadsheets it would have required more people to do the same job, or more time and less people. A higher risk would also be expected by not using a suitable system to illustrate project status and total cost of the project. It would then have been harder to make proactive corrective actions. A majority of the respondents therefore emphasized Excel spreadsheets to be a disadvantage. The main reasons were explained to be more time consuming, the disability to do extensive reporting as well as the risk of losing historical information by not making copies of important spreadsheets.

“It is more tidy and clear in PIMS, especially in terms of presenting reports in a more uniform manner.” (X2)

“All in all Excel would have been more expensive to use. I cannot see any advantages without PIMS in complex projects”. (X1)

“It would take more time to start up with Excel. Errors can easily occur, and it is easy to forget to make copies of last month’s sheets. It is also hard to receive other people’s spreadsheets, and with numerous WBS it can be difficult to update.” (X4)

One respondent doubted the quality of the cost control by using spreadsheets. The respondent explained the quality as of today to be hard to maintain in complex projects. It would have been difficult to execute the process of cost control as of how it is done today.

“The quality would have been reduced compared to the current quality we have today”. (X2)

Concerning the process of change management the respondents emphasized that spreadsheets would make the process more difficult. When making a change in PIMS all relevant information were updated, while with the use of spreadsheets this functionality had to be constructed before forwarded to relevant personnel. By using PIMS one was therefore able to make changes independent of location and specific spreadsheets

“...would have been a lot harder. With PIMS everything is updated when making a change, while in Excel this functionality has to be constructed before forwarded to persons...with PIMS one is able to make a change in England as well as in Norway without getting any consequences.” (X1)

One respondent also discussed how implementing PIMS could be valuable for some industries dealing with complex projects. As an example, the respondent mentioned the civil construction

industry, where this industry was known to have less systems concerning planning and cost control. The respondent categorized complex projects to include more than one contract and have a total cost of at least 100-200 million. In addition, the project should be of a certain size and be executed over some years. Based on this, the respondent discussed how the construction industry could make use of a system like PIMS in complex projects.

“...the civil construction industry is known to have fewer systems regarding cost control and planning, and could have needed a system like PIMS.”

(X1)

4.5 Potential improvements

In addition to the questions concerning the cost management processes, we asked the respondents about potential improvements of the PIMS CMM. The answers differed, but the main elements were concerned with the user friendliness of the system.

From the in-depth interviews there were several respondents commenting on the user friendliness of the PIMS CMM. In Company 1 most of the respondents stated that the system was easy to use. Even though most of the respondents had worked with the system for many years they emphasized that the entry level was low in order to get familiar with the system and hence use it. One expressed reason concerning the low entry level was the support from Omega, which was explained to be very quick and good. If the threshold to reach for support would have been higher, there may have been more negativity towards the system.

“PIMS CMM is easy to begin with compared to other systems. It is also quite simple to work with unfamiliar processes because you recognize most of it.” (X4)

“I have worked with the system in many years, so everything becomes easy when you first know it. I think the entry level is ok for those who need training and do not know the system from before. Some is quite self-explanatory compared to other systems such as SAP which I believe is at a higher entry level.” (X3)

“The support is very good...the support personnel know the system both technically and concerning the daily operation.” (X3)

However, several respondents expressed a possibly high entry level in order to use the system. It was explained how a system like PIMS required a great deal of training and how changes could be hard to adapt for less experienced personnel. Some respondents emphasized how the system required a high amount of experienced personnel and how it became difficult to use the system if these people were not available.

“A complex system like this requires a high amount of training. People that have been working with the system for a long time understand new changes quickly, but for others with less experience it may take longer time. Exactly how long time it will take is hard to say given that I have worked with the system for a long time. Still I do not experience any major challenges concerning the system, and I believe the system is very user friendly.” (X1)

“The entry level is too high so it requires a high amount of resources to use the system”. (Y1)

“The CMM requires good knowledge and training, preferable at the beginning.” (Y2)

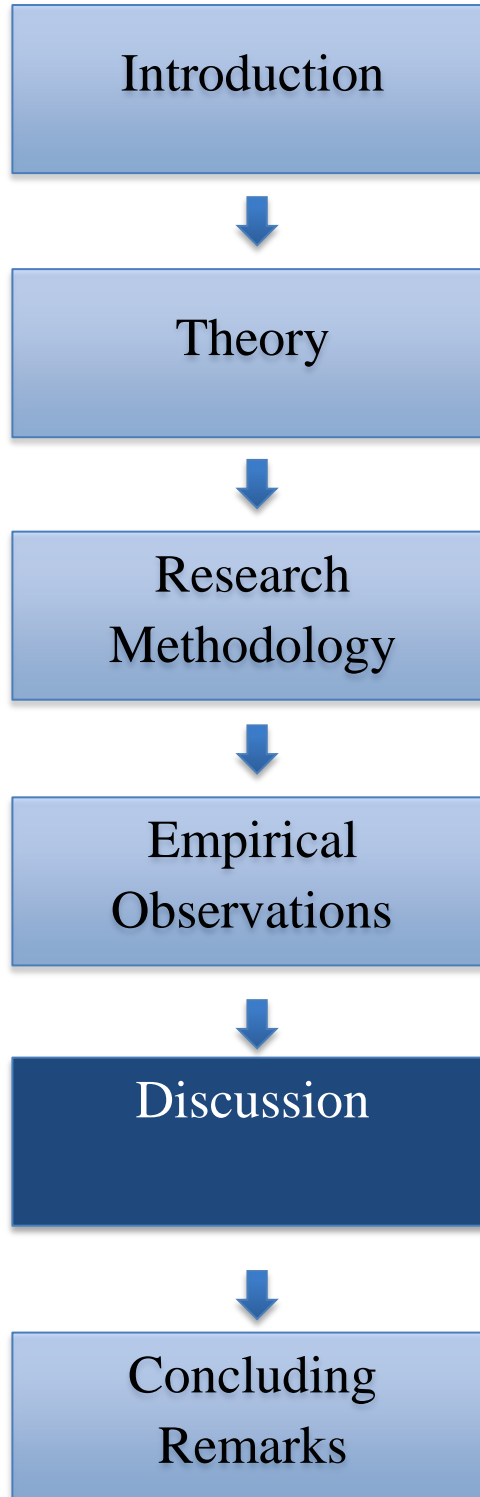
It was mentioned by Company 2 how the high entry level could be explained by too many screenshots. Respondent Y1 expressed a potential improvement of changing the structure of the module by merging several screenshots into one.

“...in general the cost module has too many screenshots. It would have been better if it was easier, simply by collecting several screenshots to one. This would have simplified the CMM a lot.” (Y1)

4.6 Comments on empirical observations

Both of the companies expressed that the PIMS CMM was a well-structured and satisfying system concerning the cost management processes, but that there existed some potential improvements. Even though the CMM was mainly focused on cost budgeting and cost control, it was expressed how the module could, to a certain degree, be used in other processes as well. In addition, it was stated that in practice most of the processes were overlapping, and that it could sometimes be difficult to discuss Cost Management as four separated processes. In the following chapter the main observations from the research will be analyzed and discussed.

Chapter 5 – Discussion



5.0 Discussion

This chapter presents and discusses effects of utilizing the PIMS CMM from the companies' perspective. We first present the observed effects supported by theory before continuing with the effects that supplement the existing theory. This chapter also presents factors that could have an impact on the effects of utilizing the PIMS CMM. Our aim with this structure is to highlight that our research has identified a wide range of effects from using the CMM.

From the research it appeared that a number of the effects of utilizing the PIMS CMM were mentioned several times. We therefore decided to divide the discussion into various categories of effects, where relevant aspects from the interviews were related to categories. We observed that parts of the observations could be closely related to the effects already identified in the literature, especially theory regarding a PMIS. However, effects also emerged that were not as closely related to theory, and could therefore be seen as supplements to the existing theory. It is important to highlight that implementing a system like the PIMS CMM does not directly generate effects. Based on this, the research identified factors that could have an impact on achieving the effects.

The research indicates several effects of utilizing the PIMS CMM, both positive and negative. The conclusions were based on how the system contributed to the cost management processes in complex projects. The effects supported by theory were categorized as follows: centralized database, improved project performance, simplified processes, change management and historical information and experience. The effects considered as supplements to the existing theory were: reduced dependency, higher quality of information and issues regarding information. Additionally, factors such as additional tools and ease of use were considered to have an impact on the effects, and will therefore be discussed as well. Each category of effect will be presented separately and concluded with a short summary.

5.1 Effects supported by theory

From the research it became clear how several of the effects were supported by theory, especially theory concerned with a PMIS. The effects were categorized in five main groups and will be discussed in order of importance.

5.1.1 Centralized database

A commonly used IT-based tool for managing a project is a PMIS. A PMIS is mainly concerned with documenting and communicating reliable project information; this means getting the right information in the right format, to the right person and at the right time (Humphreys and English 1993, Thomsen 2011). Our research showed how the respondents were gathering useful information from the centralized database in the PIMS CMM. The database made it easier for the respondents to collect reliable and important information to do further evaluations and analysis. It appeared that the centralized database enabled the companies to trust the available information and to focus on the comprehensive tasks in cost management. This could be related to Vik (2013), who states that complex projects have an extensive need to quickly store, share and gather a high amount of information.

The civil construction industry is one example where the use of a centralized database in complex projects was mentioned. One respondent stated how this industry was known to have fewer systems for planning and cost control. It was emphasized how implementing a PMIS could help the gathering and sharing of important information. The statement was based on the respondent's own experience from the oil and gas industry, and how they performed high quality cost control by using the PIMS CMM. This indicates how the civil construction industry could benefit by implementing a system like the PIMS CMM for a more efficient cost management.

From the research it appears that a centralized database was a positive aspect of the PIMS CMM, as it makes information more available and structured. This is considered highly important, since it optimizes the use of resources and reduces the time spent to perform cost management more efficiently.

5.1.2 Improved project performance

The research showed that all respondents used reports to present information about project performance. It was pointed out that the standardized reports generated by PIMS CMM were highly valued, as they generated important and reliable information about the progress of the project. This supports Thomson's (2011) research about how implementing a PMIS can contribute to improved performance by generating reports that illustrate how the project team is working. By using a reliable source of information to prepare reports, the companies were able

to illustrate and share information about project progress regularly and to monitor project performance.

Vik (2013) states that implementing a PMIS will enable the project team to focus on the final result throughout the project. This can be done by focusing on the measurement of project performance through various techniques. The main technique used is earned value management, which refers to the amount of work that was planned, compared to what is actually accomplished (PMI 2008). A majority of the respondents stated that the PIMS CMM includes the possibility to calculate the earned value, which some respondents used in their evaluations. They advised that using the earned value could assist in analyzing the cost development and the final results of the project. These comments can be related to PMI (2008) which explains how earned value contributes to an improved forecast of total costs and duration, by measuring the current performance trends. Earned value can then be used to detect possible problems ahead of time. Respondents advised that utilizing the PIMS CMM could help to take proactive actions based on available calculations.

Performance indices such as CPI and SPI can be used to get an overview of the project's performance, including how the project is progressing and the related costs (Karlsen and Gottschalk, 2005). A few respondents stated how they occasionally based their analysis on these indices calculated by the PIMS CMM, but it became clear that the use of these indices was limited. However, the research showed how major problems could have been detected by a more extensive use of such indices. These findings show how an extended use of CPI and SPI could improve cost management in projects, by providing a warning of potential budget overruns and/or delays. The use of these indices can help detect problems and take corrective action on a timely basis.

The PIMS CMM was considered by respondents as a contributor to improved project performance, by providing standardized reports with reliable information about the progress of the project. For example, a company could receive information at an early stage and thereby take pro-active actions to improve performance. This contributes to improved project performance, which is considered a positive effect.

5.1.3 Simplified processes

Theory explains that IT can create new opportunities such as improved cost efficiency. IT itself does not create value, but is interesting in terms of what level it contributes to solving a company's tasks and problems, which could generate value (Christensen, Methlie et al. 1999). Our research on the PIMS CMM identified functionalities that can simplify the cost management processes. Some of these functionalities are discussed below.

One functionality concerned currency. Based on predetermined exchange rates within the PIMS CMM, the currency function made it possible to automatically recalculate the amount on the invoice. The respondents confirmed that the automated currency function reduced workload and saved time. By not using the function, the process would become chaotic and affect the available time to do extensive reporting and analysis. This observation about the currency function in the PIMS CMM is a practical example supported by Vik (2013) who advises that an advantage of automating time-consuming processes is that it allows more time for analyzing and interpreting the information.

PMI (1996) claims that project management software could simplify the process of allocating resources. From the research on the PIMS CMM it appeared that the MPP function was used to simplify the process of resource planning. The function was also explained to have a positive influence on other processes; for example an updated MPP could be used in forecasts when reporting project status. Respondents advised that without access to the MPP function, the process of resource allocation would have been more challenging. For example, by using tools like spreadsheets, it would have been more difficult to take into consideration holidays, which the MPP does automatically. This indicates how the function could make the process of resource planning more efficient.

The PIMS CMM could also be used to timephase the estimated cost. It was explained that, based on the planned progress of the activities, it was possible to automatically timephase the estimated costs monthly. The research showed how this functionality made it easier and more flexible to timephase, and that it generated a greater overview to perform further cost processes. This is in accordance with Omega (2014) who states that the functionality of timephasing simplifies the process of cost control and generates a greater overview.

The respondents revealed some dissatisfaction with the PIMS CMM, suggesting that it should be possible to simplify the process of inputting actual costs into the PIMS CMM. This had to be done manually and was time-consuming, especially with numerous contracts. The automation of this process was recommended by respondents. This can be related to the theory by Vik (2013) that explains how automating time-consuming processes will make more time and resources available for more important processes.

By using functionalities provided in the PIMS CMM, various cost management processes became more simplified and hence the company would become more efficient. By not using a system like PIMS CMM, various processes could be more time-consuming and difficult to perform. The functionalities that simplified processes could therefore be seen as a positive effect. However, there are even further possible improvements towards an even more simplified module.

5.1.4 Change Management

According to Clark and Lorenzoni (1985), it is normal with several changes during the execution of a project. To efficiently handle changes, one could make use of a change order system. Such a system analyzes the change's impact on cost and schedule, and then incorporates this into the budget. By using an adapted system towards change management, the research on PIMS CMM showed how everything was connected. Implementing a change automatically updated all relevant information, which enabled a company to share reliable information at all times. By using a tool like spreadsheet, an automatic update would have to be constructed before being able to handle changes efficiently, which would be a more time consuming process.

Several respondents explained how they used the change feature in PIMS CMM to more efficiently update the cost estimates. They explained how the change was inserted into the change feature, where an update on remaining costs was performed every sixth month. The PIMS CMM enabled a company to develop more accurate cost estimates, through regularly updating the estimates with potential changes. This feature can be related to Vik's (2013) statement on how a PMIS enables a more efficient change handling process, by having procedures available to identify, document and approve changes.

By utilizing the PIMS CMM, a company could more efficiently handle changes in order to develop more accurate cost estimates. The project team could also be constantly updated on the latest changes, and thereby make better decisions. By making changes more efficiently, a company could trust the system to be updated with the latest information at all times. The ability to perform change management could therefore be considered as a positive effect, however not one of the major effects of utilizing the system.

5.1.5 Historical information and experience

Vik (2013) expresses that a PMIS enables a company to capture and make use of information from previous experience. From the research it became clear how the PIMS CMM could be used to extract information from previous projects. The information could then update existing data and contribute to developing more accurate cost estimates. These observations can be supported by PMI (1996), which states that there is usually available historical information from similar projects that could result in a more accurate estimate preparation. This could imply that information from previous projects can contribute to a more accurate estimate of the total project cost.

The ability of the PIMS CMM to extract historical information was considered a positive aspect, but not one of the main effects. However, it could improve a company's cost management by making relevant information available from previous projects. By using this feature, a company could learn from previous mistakes/successes, and thereby improve the accuracy of the cost estimates. Based on this, a company could share more exact numbers which could lead to increased credibility. We therefore suggest that the availability of historical information is a positive effect of utilizing the PIMS CMM.

5.2 Effects that supplements existing theory

The research discovered some effects that could be considered as supplements to the existing theory, especially regarding a PMIS. The effects were categorized in three main groups and are presented below.

5.2.1. Reduced dependency

The effect of reduced dependency was discussed when comparing the PIMS CMM to spreadsheets. By using spreadsheets a company would be more dependent on the developer, and it would be a challenge for others to make changes. This could lead to a time consuming

process, with a higher risk of dependency on specific individuals. A complex project usually consists of a high amount of information and tasks, and utilizing a system like the PIMS CMM could therefore be critical in order to reduce the dependency on specific personnel.

The research showed that the system made it easier to be informed and have access to information at all times, regardless of location. This was expressed as an advantage in companies operating in different countries, where the PIMS CMM made it possible to update and share information with personnel, independent of their location. When using spreadsheets, one had to send spreadsheets back and forth among personnel in different locations, which would be a less efficient process.

The PIMS CMM enabled a company to be more efficient by allowing several people to coordinate their work. In addition, it can be easier to undertake other people's work without depending on specific personnel and location. As a result, a company could be more flexible and less vulnerable to losing key individuals. Although reduced dependency was not entirely identified by previous research, we believe that it could be seen as a positive effect of utilizing the PIMS CMM.

5.2.2 Higher quality of information

Higher quality of information was not thoroughly described in earlier research, and could therefore be considered as a supplement to existing theory. This effect was related to how the PIMS CMM provided trustworthy information that could result in higher quality final information. The CMM provided quality control by continuously making available updated and reliable information to the project team. By using the PIMS CMM as the main source of information, a company could continuously use reliable and quality assured information, and thereby make better decisions.

Some respondents explained that not using the PIMS CMM would require more time and resources to present a final result with high quality. However, it was explained that time and resources were rarely available when working with complex projects. This could be related to the number of activities in complex projects. Using a high amount of resources on time consuming tasks could generate a high amount of unnecessary costs.

By providing information with a higher quality, the PIMS CMM can contribute to improved

results in the project. A company can then produce more accurate predictions and analysis, and thereby possess more information on the project development. This could indicate the importance of utilizing a PMIS in order to more efficiently produce results of high quality. The effect would therefore be seen as positive.

5.2.3 Issues regarding information

From the research there were some issues with regard to information, such as transferring reports from the PIMS CMM to a spreadsheet. Problems with transfer of formulas and summations, as well as issues regarding additional rows and columns were mentioned. As a result it was time consuming to make the corrections, and easy to make mistakes in the case of comprehensive reports. An improved transfer was therefore suggested, which would make the company more efficient in its cost management.

The possibility of losing historical information in the case of system updates was pointed out in the interviews. One respondent experienced the need to store information on PDF-files to make sure that they were available for a longer period of time. This could indicate some lack of reliability with the PIMS CMM, since the user had to take precautions to secure the information. Another issue identified by respondents was the lack of information concerning the estimates. It was stated that the system only illustrated the specific number related to the estimate, and nothing related to quantity and units. With this limited amount of information it became more difficult to execute further processes. This could suggest the need for improvement by having the ability to add more information to the estimates.

When utilizing the PIMS CMM, a company could experience problems with transfer and loss or lack of information. This could lead to more duplication of work as well as time used on less important tasks. For a company, this would be less efficient and could lead to a result of poorer quality. Thus, the effect could be considered as negative, but with potential improvements of transfer and by making it possible to add more information to the estimates.

5.3 Factors that could have an impact on the effects

Two factors that could be considered to have an impact on achieving positive effects were additional tools and ease of use. Both factors were presented as a prerequisite to utilize the

PIMS CMM properly in order to achieve effects, but they were also considered as potential improvements.

5.3.1 Additional tools

As the PIMS CMM was not complete in terms of carrying out the cost management processes, a factor that could be seen as a prerequisite for an optimal utilization of the system was the need for additional tools. All respondents were using additional tools to assist in the cost management processes. The reasons were the flexibility and the degree of specialization supplied by these tools, as well as requests from management. Several respondents expressed how management sometimes requested specific numbers and calculations on spreadsheets. Spreadsheets were mentioned several times as a commonly used additional tool, where important information was extracted from the PIMS CMM and further analyzed in spreadsheets. The specialized planning tool Safran was also considered essential to executing cost management. This would imply that several additional tools were needed in order to perform cost management efficiently.

Using additional tools was also pointed out as a potential improvement, where some respondents expressed the possibility of a more complete CMM. This was especially noted with regards to the process of resource planning and cost estimation, where companies were using additional tools such as Safran. They suggested that if it was possible to use a single system in all cost management processes, this would lead to higher quality results and reduce the amount of work and errors for the company.

We found that the PIMS CMM was not optimal in order to execute cost management, since various types of additional tools were needed to properly utilize the system. Spreadsheets and Safran were commonly used, however, transfer of data between various tools could result in errors. The research indicates that improvements could be needed to the PIMS CMM. However, the research implied that the improvement needed to be sufficient, where the system had to offer features of a higher quality.

5.3.2 Ease of use

Both companies agreed on how knowledge about, and experience with, the PIMS CMM was required to properly use the system. By extensively using the system, a company could be able

to achieve positive effects. However, different opinions about the entry level of the system were pointed out. The more experienced company had extensive knowledge about the module and expressed a satisfying entry level. Several features were frequently used, which simplified the cost management processes and were considered to generate positive effects. The less experienced company considered the entry level as too high, where some of the features were not as frequently used due to limited experience and knowledge. As a consequence it was harder to achieve some of the effects.

The research indicated a need for the PIMS CMM to be more user friendly for less experienced companies. The respondents from the less experienced company pointed out that they wanted a simpler module, as today's entry level was too high. When investigating how the PIMS CMM could become more user-friendly, a possible improvement would be to merge several screenshots, as the current module contained an unnecessary amount of screenshots. In addition they commented on the change module, where they expressed difficulty in connecting a change in the change module to a contract change.

The research showed how experience and knowledge with the PIMS CMM was a prerequisite to achieving the intended effects. It was also pointed out from the less experienced company that a simpler CMM with a lower entry level would be an improvement. Otherwise, it would be important to ensure sufficient training in order to achieve the experience and knowledge necessary for an optimal use of the system.

5.4 Summary of discussion

To summarize this discussion, we have developed a model (Model 5.1) that presents our results. The model illustrates three different aspects:

- effects supported by theory,
- effects that supplements existing theory,
- factors that could have an impact on the effects.

We have further categorized the effects into what was considered as positive and negative effects. The positive effects are presented with a (+), while the negative effects are presented with a (-).

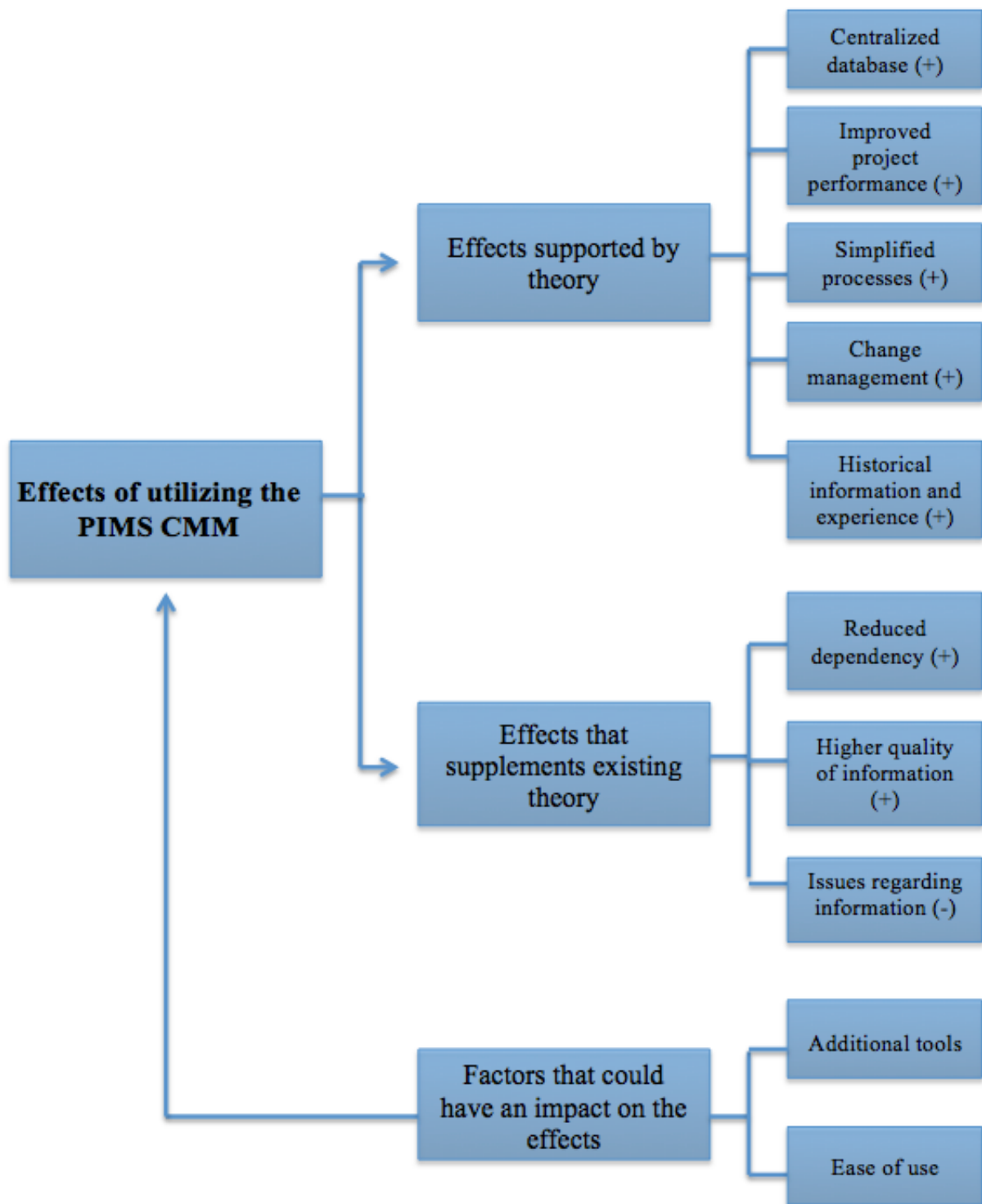
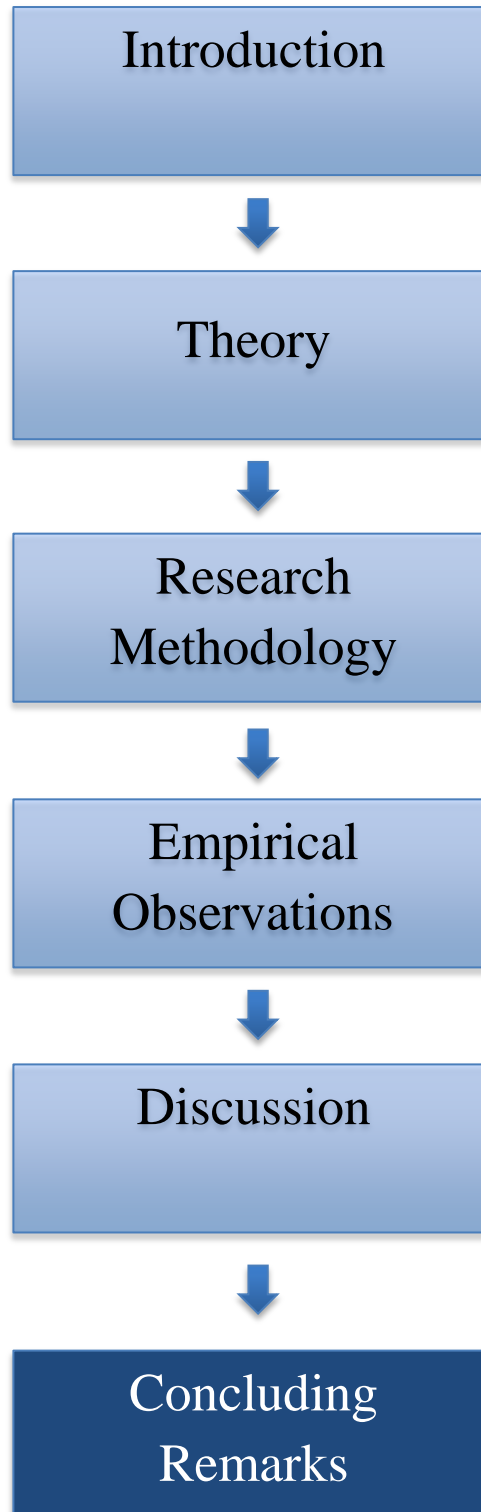


Figure 5.1: Effects of utilizing the PIMS CMM

Chapter 6 – Concluding Remarks



6.0 Concluding Remarks

In this chapter the most important observations from the research will be presented. Thereafter, the limitations of the study as well as suggestions for further research will be introduced.

In this research we have examined the effects of utilizing the PIMS CMM in the cost management processes. The effects could be considered as either supported by theory or as a supplement to existing theory. In addition, our research identified factors that could have an impact on achieving the effects. The effects supported by theory were as follows: centralized database, improved project performance, simplified processes, change management and historical information and experience. The effects that were considered as supplements to the existing theory were categorized as follows: reduced dependency, higher quality of information and issues regarding information. Finally, the factors that could have an impact on the effects were additional tools and ease of use. The research showed a common satisfaction of using the PIMS CMM in cost management, where the effects were considered as mostly positive. However, a few effects were considered as more negative with potential improvements. In addition, to achieve some of the effects, a company needs to acknowledge the importance of using additional tools as well as possessing extensive knowledge about, and experience with, the system.

Limitations

Our thesis consists of some limitations. One of them is that we were not able to search for the effects by looking at the before-after situation of implementing a PMIS. Our sources had already been using the PIMS CMM for several years; however we were able to detect various effects. Another limitation is that we were only able to include two of Omega's customers working with complex projects in the oil and gas industry. This was due to limitations of time and resources, but it could be interesting to explore other customers and industries operating with less complex projects. In addition, another limitation was concerned with difficulties of finding previous research on effects of using a PMIS, where we decided to use only two aspects of previous research. With these limitations, it is difficult to generalize the results, but they

could function as an indicator on how a system like PIMS would affect your business concerning the cost management processes.

Further research

More extensive research

During our study we experienced that research of implementing a PMIS and possible effects are limited. We only managed to find two proper aspects of values of implementing a PMIS. This indicates that implementing a PMIS is a relative undiscovered research topic. It could therefore be interesting to do more extensive research on this topic in order to compare the results.

Larger sample – qualitative study

As our sample only consisted of two of Omegas customers it would be interesting to do the study with a larger sample. More insights and valuable information could then be discovered. A larger sample could be interesting in terms of identifying potential differences concerning other effects or impacts on the effects of using the PIMS CMM

Quantitative study

It would be interesting to perform a quantitative study with focus on the effects from this research. Quantitative research focuses on numerical measurement and would be interesting in terms of studying the effects of the PIMS CMM across a larger sample. By using a large sample size it could be possible to achieve results that can be representative for the population in general.

Different industries working with less complex projects

As our research is concerned with complex projects in the oil and gas industry there is a possibility to execute a similar research related to other industries working with less complex projects. It could then be interesting to compare these results from our study with to a study on less complex projects in other industries to investigate if there are any differences or other positive or negative effects.

Before - after the implementation

Another possible research opportunity would be to do a research based on the before-after situation when implementing a PIMS. As our research is based on companies that have been

using the system for several years, it would have been interesting to do a research on effects that emerged from implementing the PIMS CMM.

Focus on PIMS in general

In this study we have only focused on the PIMS CMM. It could therefore be interesting to include other modules to be able to study how implementing the system with several modules affects a company.

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Appendix 1: Intervjuguide til Omega på norsk

Intervjuguide Omega AS

Vi ønsker å se på effekten av PIMS ved å se hvordan kundene bruker PIMS til kostandsstyring. Vi tenker det vil være interessant for dere ettersom vi prater med viktige kunder og får deres perspektiv på opplevde effekter av systemet. Dette kan dere bruke videre til nye alternative kunder o.l.

- 1) Hvor lenge har du jobbet i Omega, og spesifikt med prosjektstyring og PIMS?
- 2) Har du noen formening om utviklingen av PIMS? Hvorfor Pims? Erfaring?
- 3) Har du tidligere jobbet andre steder med evt. andre programmer?Excel?

Vi har delt intervjuet inn i fire hovedelementer, og vil ha spørsmål tilknyttet hver og en av disse. I hver av disse fire har vi igjen delt inn i to hoveddeler; i den første vil vi høre hvordan PIMS bidrar i de ulike prosessene, for deretter å se hvordan disse prosessene hadde blitt gjennomført uten PIMS med eventuelle andre verktøy.

Ressurplanlegging	Oppfølgingsspørsmål
Hvordan kan PIMS benyttes til ressurplanlegging i et prosjekt? →	<ul style="list-style-type: none"> • Er det noen spesielle funksjoner i PIMS som er viktig i denne prosessen?(<i>fremstilling av data, endringer → forenkler</i>) • Forenkles/vanskeliggjøres enkelte prosesser ved å bruke PIMS? • Hva tenker du om tilgjengeligheten av informasjon i PIMS ang. ressurser? Er den lett å hente og distribuere til alle parter?
Uten PIMS, hvordan vet/tror du da ressurplanleggingen ville foregått?	<ul style="list-style-type: none"> • Er det vanlig å bruke andre verktøy/systemer for å gjennomføre ressurplanlegging, hvordan/hvorfor? • Er det noen prosesser man enklere kunne gjennomført uten PIMS, i så fall hva? • Hva er de største forskjellene mellom å bruke/ikke bruke PIMS?

Kostnadsestimering	Oppfølgingsspørsmål
Hvordan kan PIMS benyttes til kostnadsestimering i prosjekter? →	<ul style="list-style-type: none"> • Er det viktige verktøy i PIMS som gjerne forenkler estimeringsarbeidet? • Hva kan en database bidra med i estimeringsprosessen?(<i>Tilgjengelige ressurtyper, priser →Forenkler</i>) • Føler du estimeringsprosessen er mer eller mindre standardisert med et verktøy som PIMS? Fordel? • Hvordan tar PIMS hensyn til potensiell risiko i estimatene? • Hvordan er det å foreta endringer i estimatene i PIMS?
Uten PIMS, hvordan vet/tror du da kostnadsestimeringen ville foregått?	
	<ul style="list-style-type: none"> • Er det vanlig å bruke andre verktøy/systemer for å estimere kostnader, hvordan/hvorfor? • Hva tror du vil være de største forskjellene fra å bruke PIMS? • Hva tenker du rundt tid, kostnad og kvalitet ved estimering uten PIMS? • Hvordan fungerer importering av estimater fra andre IT-verktøy? • Hva tenker du rundt mulighet til å foreta endringer uten PIMS?

Kostnadsbudsjettering	Oppfølgingsspørsmål
Hvordan kan PIMS benyttes til kostnadsbudsjettering i prosjekter?	<ul style="list-style-type: none"> • Er det spesifikke verktøy i PIMS som forenkler arbeidet med budsjettering/baseline? • Hvor godt egnet er PIMS til å innhente budsjetterte og faktiske tall • Hvordan bidrar PIMS til kommunikasjon på tvers av avdelinger/bedrifter?(<i>for eksempel informasjon mellom de som arbeider med styring og regnskap</i>)
Uten PIMS, hvordan vet/tror du da kostnadsbudsjetteringen ville foregått?	
	<ul style="list-style-type: none"> • Er det mulig å bruke andre verktøy/systemer til budsjettering/baseline, hvordan/hvorfor? • Hva tror du vil være den største forskjellen? • Hva tenker du rundt tid, kostnad og kvalitet ved budsjettering uten PIMS? • Uten en sentralisert database, hva er konsekvensene med hensyn på baseline?

Kostnadskontroll	Oppfølgingsspørsmål
<p>Hvordan kan PIMS benyttes til kostnadskontroll?</p>	<ul style="list-style-type: none"> • Er det noen spesielle funksjoner/beregninger PIMS benytter i denne prosessen? (<i>Earned value management, fremdriftsmåling/indekser, forecasting</i>) • Hvordan hjelper PIMS kunden til å få en bedre overblikk over dagens situasjon? • Hvordan er brukervennligheten i PIMS til å utføre kostandskontroll?(<i>automatiserte prosesser</i>) • Hvordan er mulighetene til å foreta endringer underveis? • Har du erfaring og tanker om hvorvidt beslutningsgrunnlaget forsterkes/svekkes med hensyn til PIMS? Hvorfor?
<p>Uten PIMS, hvordan vet/tror du da kostnadskontrollen ville foregått?</p>	<ul style="list-style-type: none"> • Er det bedrifter som bruker andre verktøy/systemer i denne prosessen, hvordan/hvorfor? • Utdyp de største forskjellene med vs uten PIMS med tanke på kostnadskontroll. (<i>får info senere, dobbeltarbeid, avvik, vanskelige å endre</i>) • Hvilke konsekvenser kan oppstå ved å ikke bruke PIMS til kostandskontroll?

1) Hvordan hjelper PIMS kunden til å få en bedre overblikk over dagens situasjon?

2) Er det funksjoner i PIMS som har et forbedringspotensial? Komplett produkt?

3) Hvilke forutsetninger bør ligge til grunn for en optimal utnyttelse av PIMS Cost Management? Utdyp disse! (Tips: teknisk support, kompatibilitet, brukervennlighet, tilgjengelig opplæring, tilbakeholde informasjon etc.)

4) Hva er typiske utfordringer dere står ovenfor med eksisterende/nye kunder som bruker PIMS Cost Management?

5) Har dere stort sett kunder med komplekse prosjekter, eller ser det potensiale til å selge PIMS til kunder med mindre prosjekter?

6) Hva er argumentene til bedrifter som mener de ikke behøver et system som PIMS til å styre et prosjekt?

Appendix 2: Interview guide to Omega in English

We want to look at the effects of utilizing PIMS and how the customers use PIMS to execute cost management. We believe this could be interesting for your company as we will interview important customers to get their perspectives on the effects of utilizing the system. This could further be used to new customers.

- 1) How long have you worked in Omega, and more specific project control and PIMS?
- 2) Do you have any opinion about the development of PIMS? Why PIMS? Experience?
- 3) Have you worked other places with other systems or tools? Excel?

Resource planning	Follow- up questions
<p>How can PIMS contribute in resource planning of a project? →</p>	<ul style="list-style-type: none"> • Are there any typical functions in PIMS which are important in this process? <i>(Representations of data, changes → simplifies)</i> • Are there some processes that gets simplified / complicated when using PIMS? • What are your thoughts of the availability of information in PIMS regarding resources? Is it easy to pick out and distribute to all interests?
<p>Without PIMS, how to you know/ believe that resource planning would have been executed?</p>	<ul style="list-style-type: none"> • Is it normal to use other tools/ systems to execute the resource planning, how/why? • Are there any processes which could have been executed easier without PIMS, if so, what? • What are the greatest differences between using and not using PIMS?

Cost Estimating	Follow- up questions
How can PIMS be used in cost estimating in projects?	<ul style="list-style-type: none"> • Are there important tools in PIMS that could simplify the work of estimation? • What could a database contribute with in the process of estimation? <i>(Access to resource types, prices → simplifies)</i> • Do you believe the estimation process is more or less standardized with a tool like PIMS? An advantage? • How do PIMS take care of potential risk in the estimates? • How is it to make changes in the estimates in PIMS?
Without PIMS, how do you know/ believe that the cost estimating would have been executed?	<ul style="list-style-type: none"> • Is it normal to use other tools/systems to estimate costs, how/ why? • What do you believe would be the greatest differences from using PIMS? • What are your thoughts about time, costs and quality in the estimates without PIMS? • How does the process of importing estimates from other IT- tools work? • What are your thoughts about the opportunity to make changes without PIMS?

Cost Budgeting	Follow-up questions
How can PIMS contribute to cost budgeting in projects?	<ul style="list-style-type: none"> • Are there features in PIMS that simplifies the preparation of work considering the budget/ baseline? • How well suited is PIMS to collect budgeted and actual numbers? • How is PIMS contributing to communication across departments/ companies? (<i>E.g.: information between those who work at the management and accounting?</i>)
Without PIMS, how do you think cost budgeting would have been executed?	
	<ul style="list-style-type: none"> • Is it possible to use other tools/ systems for budgeting/ baseline? How and why? • What do you believe is the greatest difference? • What are your thoughts about time, costs and quality when performing cost budgeting without PIMS? • Without a centralized database, what are the consequences considering the baseline?

Cost Control	Follow- up questions
How can PIMS be used to perform cost control?	<ul style="list-style-type: none"> • Are there any special features/ calculations that PIMS use in this process? (<i>Earned value management, progress measurement/ indices, forecasting</i>) • How does PIMS contribute to a better overview of the current situation? • How is the user friendliness of PIMS to perform cost control? (<i>Automate processes?</i>) • How are the possibilities to make changes along the way? • Do you have any experience and thoughts whether the decision basis is enhanced/ weakened considering PIMS? Why?
Without PIMS, how do you know/ believe the cost control process would have been executed?	
	<ul style="list-style-type: none"> • Are there companies that use other tools/ systems in this process? How/ why? • Explain the main differences with/ without PIMS considering cost control. (<i>Get information later,</i>

	<p><i>duplication, deviations, more difficult to make changes)</i></p> <ul style="list-style-type: none">• What consequences do you think can occur by not using PIMS in cost control? Experience?
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- 1) How does PIMS assist the customer to get a better overview of the current situation?
- 2) Are there any features in PIMS that have potential improvements? Complete product?
- 3) What assumptions should underlie an optimal utilization of PIMS Cost Management?
Elaborate this! (Tip: technical support, compatibility, usability, available training, withholds information etc.)
- 4) What are typical challenges you face with existing/ new customers who use PIMS Cost Management?
- 5) Do you mostly have customers operating with complex projects, or is there any potential to sell PIMS to smaller customers with smaller projects?
- 6) What are the arguments from the companies that believe they do not need a system like PIMS to manage a project?

Appendix 3: Intervjuguide til bedriftene på norsk

Intervjuguide Bedrift 1 og Bedrift 2

Vi skriver vår masteroppgave for Omega, og oppgaven baserer seg på en analyse av effekten av å bruke et prosjektstyringssystem som PIMS. Vi har avgrenset oppgaven til å se på bruken av PIMS til kostnadsstyringen i prosjekter. Vårt mål med intervjuet er å få ditt perspektiv på hvordan du bruker PIMS i din arbeidshverdag og de opplevde effektene.

- 1) Hvor lenge har du jobbet i (Bedriftsnavn)?
- 2) Hvor lenge har du jobbet med prosjektstyring og PIMS?
- 3) Har du tidligere jobbet andre steder med evt. andre programmer? Excel?

Ettersom teorien deler kostnadsstyringen inn i fire deler (ressurplanlegging, kostnadsestimering, kostnadsbudsjettering og kostnadskontroll) har vi valgt å ta utgangspunkt i disse når vi har utarbeidet intervjuet. Selv om PIMS er et prosjektstyringsverktøy med fokus på budsjett og kontroll, ønsker vi likevel å få ditt perspektiv på om PIMS bidrar noe i ressurplanleggingen og kostnadsestimeringen i tillegg. For strukturen sin del prøvd å hold deg til hver enkelt prosess.

Ressurplanlegging	Oppfølgingsspørsmål
Kan PIMS bidra noe i arbeidet med ressursplanleggingen, i så fall med hva?	<ul style="list-style-type: none"> • Kan PIMS benyttes til å planlegge personell, og hvordan fungerer dette? Brukes dette ofte? • Skulle du ønske PIMS inneholdt en mer komplett planleggingsfunksjon? (<i>avhengigheter mellom arbeidspakker o.l.</i>) • Forenkles/vanskeliggjøres enkelte prosesser i planleggingen ved å bruke PIMS? • Hva tenker du om tilgjengeligheten av informasjon til ressurplanleggingen i PIMS?
Generelt, vet du hvordan planleggsprosessen foregår i et prosjekt – fortell kort.	<ul style="list-style-type: none"> • Skulle du ønske PIMS kunne benyttes i hele ressursprosessen i fremtiden? Eller fungerer planlegging av ressursene optimalt nå? • Kunne prosessen(planleggingen av materialer) blitt forenklet/vanskeliggjort ved bruk av PIMS?

Kostnadsestimering	Oppfølgingsspørsmål
<p>Kan PIMS bidra noe i arbeidet med kostandsestimering, i så fall hvordan?</p>	<ul style="list-style-type: none"> • Hvilke funksjoner finnes i PIMS mht estimatene?(<i>klassifisere,legge på time/lengderater,endre,tilgang på info til tidligere prosjekter, inflasjonsjustere</i>) • Hvordan føler du tidligere erfaringstall/historiske data i PIMS bidrar i estimeringen? • Skulle du ønske det var en komplett estimeringsfunksjon i PIMS? • Hvor enkelt implementeres estimatene til PIMS, og hvorfor? • Føler du PIMS gir en oversiktlig WBS, og hvordan bidrar denne i estimeringen? • Hvordan er mulighetene til å foreta endringer i estimatene i PIMS? Kan man sammenligne estimater før/etter endringer? • Vil du si PIMS bidrar til å redusere risiko ved å ha gode muligheter til å foreta evt. endringer kontinuerlig?
	<ul style="list-style-type: none"> • Hva tror du er bakgrunnen for at estimeringen foregår uten et verktøy som PIMS? • Skulle du ønske PIMS inneholdt en komplett estimeringsfunksjon, og hvorfor?

For best mulig forståelse av effekten med tanke på budsjettering og kontroll har vi delt spørsmålene inn i to; første del omhandler hvordan PIMS bidrar i prosessen, mens andre del omhandler tanker om hvordan prosessen hadde vært utført uten PIMS.

Kostnadsbudsjettering	Oppfølgingsspørsmål
<p>Hvordan bidrar PIMS til å sammenstille data som trengs til å utforme baseline?</p>	<ul style="list-style-type: none"> • Er det funksjoner i PIMS som forenkler arbeidet med fremstilling av baseline? • Hvordan bidrar PIMS til å gi en god oversikt over kostnader til videre kontroll? • Hva blir konkret enklere/vanskeligere med PIMS?(<i>kommunikasjon, distribusjon, beslutninger</i>) • Mener du PIMS er et godt verktøy til å fremstille baseline, og hvorfor?(<i>pålitelige/riktige tall til enhver tid</i>) • Hvordan påvirkes budsjetteringen av en sentralisert database?
<p>Uten PIMS, hvordan vet/tror du da kostnadsbudsjetteringen ville foregått? Gjerne del erfaring med for eksempel bruk av excel</p>	<ul style="list-style-type: none"> • Hvilke problemer tror du ville oppstått uten bruk av et prosjektstyringssystem?(<i>tid, kostnad, kvalitet</i>) • Hva tror du vil være de største forskjellene? • Hvordan ville det da fungert å foreta endringer? • Hva tenker du om distribusjon av informasjon rundt baseline uten et system som PIMS?

Kostnadskontroll	Oppfølgingsspørsmål
<p>Fortell hvordan du/dere bruker PIMS til kostnadskontroll</p>	<ul style="list-style-type: none"> • Er det noen spesielle funksjoner/beregninger PIMS benytter i denne prosessen? (<i>Earned value management, fremdriftsmåling, forecasting</i>) • Hvordan hjelper PIMS til et bedre overblikk over dagens situasjon og evt. avvik/varsianser fra baseline? • Har du noen tanker om oversikten over bruk av contingency i PIMS? Reduserer dette risiko for overskridelse ved rask tilgang til info? • Hvordan er mulighetene til å foreta endringer underveis? • Hvordan er brukervennligheten i PIMS til å utføre kostandskontroll?(<i>standardiserte prosesser?</i>) • Har du erfaring og tanker om hvorvidt beslutningsgrunnlaget forsterkes/svekkes mht PIMS?Hvorfor?
<p>Uten PIMS, hvordan vet/tror du da kostnadskontrollen ville foregått?</p>	<ul style="list-style-type: none"> • Utdyp de største forskjellene med/uten PIMS med tanke på kostnadskontroll. (<i>får info senere, dobbeltarbeid, avvik, vanskelig å endre</i>) • Har du erfaring fra prosjekter hvor PIMS ikke var nødvendig å bruke til kostnadskontroll, og hvorfor? • Hvilke konsekvenser tror du kan oppstå ved å ikke bruke PIMS til kostandskontroll?Erfaring?

Til slutt:

- 1) Hvordan ville du oppsummert at arbeidsdagen din påvirkes av at du bruker et system som PIMS vs å ikke bruke et prosjektstyringssystem?
- 2) Hvilke forutsetninger vil du si bør ligge til grunn for en optimal utnyttelse av PIMS Cost Management? Utdyp disse! (Tips: teknisk support, kompatibilitet, brukervennlighet, tilgjengelig opplæring, tilbakeholde informasjon etc.)
- 3) Er det funksjoner i PIMS du savner/ville ha forbedret?

Appendix 4: Interview guide to the companies in English

Interview guide for Company 1 and Company 2

We are writing our master thesis for Omega, and our thesis is based on an analysis of the effects of using a project control system like PIMS. We have limited our thesis to focus on using the system in cost management in projects. Our aim with the interview is to get your perspective on how you use PIMS in your day at work and the effects.

- 1) How long have you worked in (Company name)?
- 2) For how long have you worked with project control and PIMS?
- 3) Have you worked other places with different systems or tools? Excel spreadsheets?

Resource planning	Follow- up questions
<p>Can PIMS contribute to the work of resource planning? If so, with what?</p>	<ul style="list-style-type: none"> • Can PIMS be used to plan personnel, and how does this work? Is it used often? • Did you wish PIMS contained a more complete planning function? (Dependencies between the work packages e.g.) • Are some processes in planning simplified/ complicated when using PIMS? • What is your thought on the availability of information in PIMS?
<p><i>In general, do you know how the planning process is executed in a project? Explain briefly!</i></p>	<ul style="list-style-type: none"> • Did you wish that PIMS could have been used throughout the entire process of resource planning in the future? Or is resource planning optimal as it is today? • Could the process (planning of materials) have been simplified/ more difficult by using PIMS?

Cost Estimating	Follow- up questions
<i>Can PIMS contribute in the work of cost estimating? If so, how?</i>	<ul style="list-style-type: none"> • Which functions exist in PIMS considering the estimates? (Classification, add hours/ rate of length, change, access to information from earlier projects, inflation, etc.) • How do you feel that historical data in PIMS contributes in cost estimating? • Do you wish PIMS had a more complete estimation function? • How easy is it to implement the estimates into PIMS, and why? • Do you feel that PIMS generate a clear WBS, and how does this contribute in the estimation process? • How is the opportunity to make changes in the estimates? Is it possible to compare estimates before and after changes? • Is it possible to say that PIMS contribute to reduced risk by having opportunities to make changes continuously?
	<ul style="list-style-type: none"> • What do you think is the reason that cost estimating are done without a tool like PIMS? • Did you wish PIMS contained a complete estimation function, if so, why?

For best possible understanding of the effects considering the cost budgeting and cost control we have decided to divide the questions into two: first part discusses how PIMS contributes in the process, while the second part deals with thoughts on how the process had been conducted without PIMS.

Cost budgeting	Follow-up questions
<p><i>How does PIMS contribute to compile the data needed to generate a baseline?</i></p>	<ul style="list-style-type: none"> • Are there features in PIMS that simplifies the work of preparation for the baseline? • How does PIMS provide a good overview of the costs for further control? • What are concretely more easy / complicated with PIMS? <i>(Communication, distribution, decisions?)</i> • Do you believe PIMS is a good tool to prepare for baseline, and why? <i>(Reliable/ correct numbers at any time)</i> • How does a centralized database influence the cost budgeting?
<p><i>Without PIMS, how do you think cost budgeting would have been performed? Share experience with for example use of Excel spreadsheets.</i></p>	<ul style="list-style-type: none"> • What problems do you believe would have arisen without utilizing project management software? <i>(Time, cost, quality)</i> • What do you think will be the biggest differences? • How would it then have been to make changes? • What do you think about the distribution of information about baseline without a system like PIMS?

Cost control	Follow- up questions
<p>Tell us about how you use PIMS in the process of cost control.</p>	<ul style="list-style-type: none"> • Are there any typical features/ calculations that PIMS uses in this process? <i>(Earned value management, progress measurement, forecasting)</i> • How does PIMS contribute to a better overview of the current situation and potential deviations from the baseline? • Do you have any thoughts about the overview PIMS generate for the contingency? Does it reduce the risk for overrun by having fast access to information? • How are the possibilities to make changes along the way? • How is the user friendliness of PIMS to perform cost control? <i>(Standardize processes?)</i> • Do you have any experience and thoughts whether the decision basis is enhanced/ weakened by using PIMS?
<p>Without PIMS, how do you think cost control would have been executed?</p>	<ul style="list-style-type: none"> • Explain the main differences with/ without PIMS considering cost control. <i>(get information later, double work, deviations, difficult to make changes)</i> • Do you have any experience from projects where PIMS was not necessary to use in cost control, and why? • What consequences do you think can occur by not using PIMS to cost control? Experience?

Finally:

- 1) How would you summarize how your working day gets affected by using a system like PIMS versus not using a project management system?
- 2) What assumptions should be the basis for an optimal utilization of the PIMS Cost Management Module? Elaborate them! (Tip: technical support, compatibility, usability, available training, withholding of information, etc.)
- 3) Are there any features in PIMS you miss/ would have improved?