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ADAPTING BENCHMARKING TO PROJECT MANAGEMENT:

AN ANALYSIS OF PROJECT MANAGEMENT PROCESSES, METRICS, AND BENCHMARKING PROCESS MODELS

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PREFACE

This dissertation work has been carried out as a dr. ing. (ph. d.) student in project management at the Norwegian University of Science and Technology (NTNU), Faculty of Mechanical Engineering, Department of Production and Quality Engineering. The dr. study have been within Project 2000 (PS 2000), a research program in project management, that also has given me financial support.

The main part of this work has been done at NTNU in Trondheim, Norway. Other locations of my dr. studies have been with Extraordinariat für Projektmanagement (EO) in Vienna, Austria, and at The University of Texas at Austin with it's Construction Industry Institute (CII) and Civil Engineering Project Management Program in Austin, Texas, USA.

My dr. studies started in May 1994. The dissertation topic on benchmarking of project management was selected October, 1995. The overall purpose of the dissertation has been to better the adaption of benchmarking to project management. The dissertation work has been sought balanced between a practical focus to benefit industry and Project 2000 members, and an academic focus to comply with university requirements.

Structure of the dissertation report

The dissertation report has been divided in three parts of research areas and thirteen chapters:

Chapter 1 introduces the research program *Project 2000*, and the terms *Project Management* and *Benchmarking*.

Chapter 2 explains the background or rationale for the dissertation research.

Chapter 3 states the purpose of the dissertation research, and explains the management and methodology of the research.

Part 1 contains work on project management processes and consists of chapters 4 and 5.

Chapter 4 describes two sets of project management processes encountered in literature, and selects one for further use.

Chapter 5 presents survey part 1 conducted to identify experienced project management personnel's' perceptions of the selected set of project management processes.

Part 2 contains work on metrics and consists of chapters 6 to 8.

Chapter 6 presents relevant identified research and literature on metrics.

Chapter 7 explains this dissertations approach to develop metrics and presents suggestions to metrics for each of 37 project management processes.

Chapter 8 presents a feedback on this dissertation's metrics work, conducted through survey part 2.

Part 3 contains work on benchmarking process models and consists of chapters 9 to 12.

Chapter 9 discusses potentials and problems of benchmarking in the project environment, and develops evaluation criteria for benchmarking process models fit for benchmarking of project management processes.

Chapter 10 describes the work done on analyzing existing benchmarking process models after the developed evaluation criteria.

Chapter 11 presents and describes the work to develop a new benchmarking process model that is targeted to fit for benchmarking of project management processes.

Chapter 12 evaluates the new benchmarking process model and compares it with existing models.

Chapter 13 summarizes the dissertation work and presents areas for future research.

Acknowledgments

This dissertation is not only the product of my own work. I have had help from several individuals and groups of people who have contributed on the way to it's completion. The ones who have helped me know who you are, and I would like to thank you all for inputs and support! I have below given my specific thanks to some of you. Many others could have been listed, but I hope for your understanding for selecting only a few in order to limit this section.

First, I want to thank my supervising professor Asbjørn Rolstadås, who has let me set the directions of the research and has supported my choices, after striking comments that have forced me to argue for my choices and kept me focused on the topic. Second, I want to thank Bjørn Andersen for influencing me to select the project management benchmarking topic and guide me on benchmarking issues. With an Engineering background, it took a while before I realized that this research was a social science study. Being in this new environment, created interesting challenges and learning, as well as smaller frustrations.

I would also like to thank the organizations and individuals in Project 2000 for financial and professional support. A special thanks goes to Project 2000's program coordinator Halvard Kilde for believing in me and encouraging me

during the study. His positive attitude and “jokes” have meant a lot for moral support.

A warm thanks goes to Dr. Roland Gareis of EO and Dr. Richard Tucker of CII and their associates for their hospitality and professional encouragement. The visits to these two project management environments were valuable both in a scientific and social way.

My warmest thanks goes to my wife Tone, who has supported and believed in me all the way, in addition to proofreading parts of the dissertation. I could not have done this work without her love and support. My thanks goes also to my two sons, Morten Thomas and Kristian, for not messing with or tearing apart any piece of research materials or manuscripts, in addition to bearing with me when I often have been absent in both mind and body due to this dissertation work. I dedicate this work to my beloved wife Tone and my children.

Trondheim, August 12, 1997.

Kjetil Emhjellen

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ABSTRACT

Since the first publication on benchmarking in 1989 by Robert C. Camp of "Benchmarking: The search for Industry Best Practices that Lead to Superior Performance", the improvement technique benchmarking has been established as an important tool in the process focused manufacturing or production environment. The use of benchmarking has expanded to other types of industry. Benchmarking has past the doorstep and is now in early trials in the project and construction environment. Literature and current research show an increasing interest for the use of benchmarking for improvement in the project environment. However, no encountered work have done the necessary adaption of the technique from its original environment to the project and construction environment. Furthermore, no encountered work has focused on benchmarking of project management processes only.

The overall purpose of this dissertation research was to better the adaption of benchmarking to the project environment with a focus on project management, so an organization or a group of organizations better can use benchmarking for improving their project management. The research effort was divided into 3 parts.

The first part's objective was to indicate strong and weak areas of project management areas or processes, in order to aid in deciding on where the improvement technique benchmarking should focus. A set of project management processes from the 1996 "A Guide to the Project Management Body of Knowledge" by the Project Management Institute (PMI) was selected for further use in the dissertation research. Since this set of processes was to be used extensively, a mail survey was conducted among experienced project management personnel to collect their subjective opinions on the set of processes. The findings from the respondents' construction project perspectives, indicated strongly that all project management processes defined by PMI are important and none are superfluous. The findings indicated further that for some projects, the project management processes by PMI were quite complete, but not for others. In the participants' opinion, the PMI developed project management processes illustrate quite well the project management processes on their reference projects and for constructions projects in general. It is thus reasonable to believe, that the PMI processes quite well illustrate project management processes in construction type of projects.

In the same mail survey, questions were asked in order to indicate areas or processes of project management where the improvement need were highest and where improvement efforts like benchmarking should be focused. The participants were asked for their opinion of importance and performance to each of the 37 PMI project management processes. By analyzing the gap between importance and performance for each project management process, the

findings includes that the project management processes performed early in the reference projects, i.e. initiating and planning processes, were identified to be of highest need of improvement. For the individual project management processes, the participants' answers indicate that the following 12 had the highest need of improvement. In order of improvement need, the processes are:

1. Initiation	5. Staff Acquisition	9. Team Development
2. Risk Identification	6. Scope Planning	10. Schedule Development
3. Communications Planning	7. Risk Quantification	11. Quality Control
4. Organizational Planning	8. Quality Planning	12. Cost Estimating

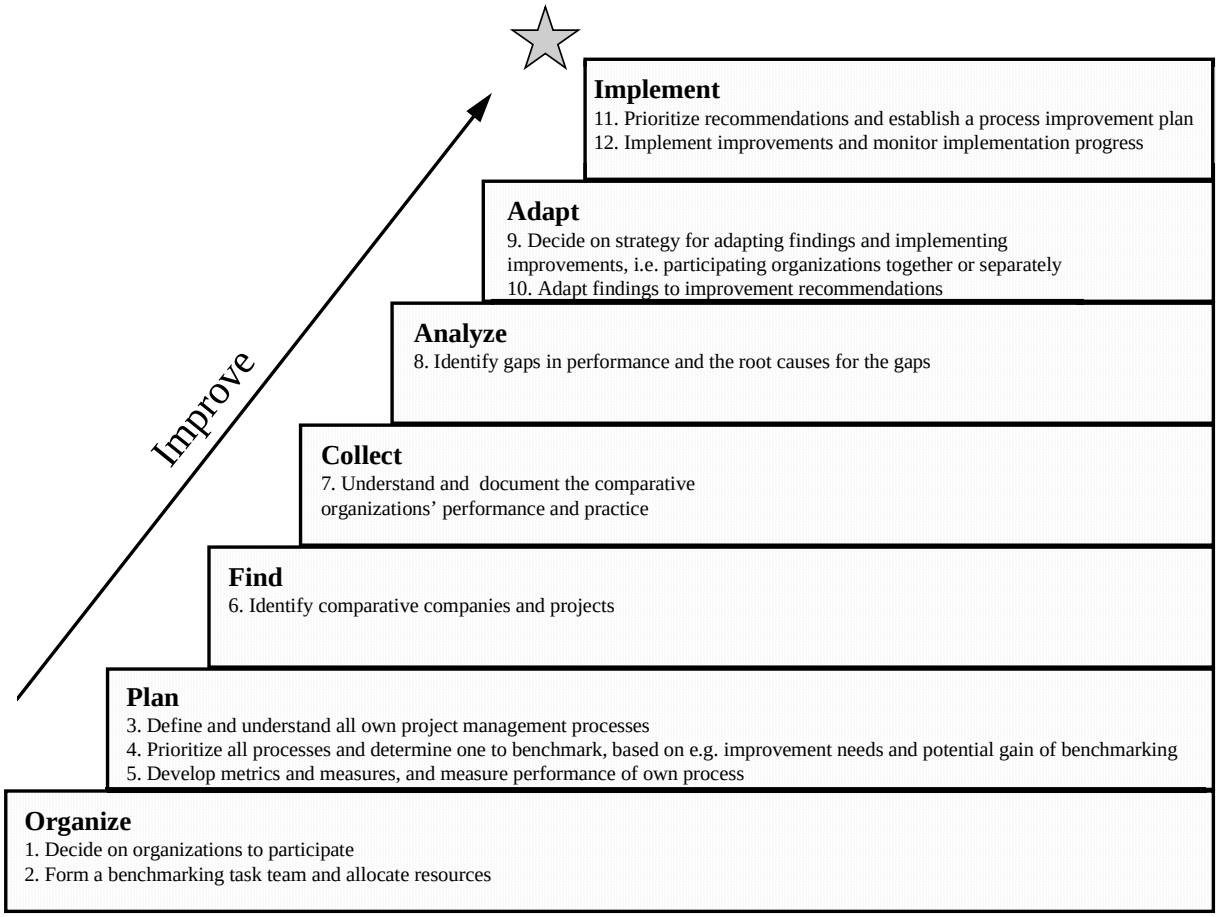
The second part of this dissertation's research had an objective to suggest metrics for project management processes, that can be looked up and used as an aid for potential benchmarkers to define metrics for their own special project management processes. No metrics encountered in literature or existing research were developed for project management processes directly. Furthermore, no set of metrics that directly focus on project management only were encountered.

Based on a combination of encountered metrics in the literature, inputs from interviews with experienced project management personnel, and creative thoughts of the author of this dissertation, this research therefore developed metrics for the 37 PMI defined project management processes. However, the suggested metrics to each project management process are not meant to be universal metrics for the project management processes in question. The lists of metrics are meant to be a place for potential benchmarkers to get ideas for their own project management processes. Thus, the metrics are not meant to be used directly, but need to be adjusted to the project management processes of the organization in question.

Using the suggested lists of metrics, metrics to one project management process was tested in a survey part 2 to get some feedback on the metrics work. The process was Risk Identification. As a whole, the participants leaned clearly towards a positive opinion to the suggested metrics.

The objective of the third part of the dissertation research effort, was to evaluate existing benchmarking process models' fitness for benchmarking of project management processes, and if necessary, suggest a new model that is targeted to fit for benchmarking of project management processes. A sample of existing benchmarking process models was evaluated, in order to see if they were fit to guide in a benchmarking of project management processes. The research concludes that none of them could guide users through a complete benchmarking study of project management processes. The evaluation exercise led to an increased knowledge about what constituted strong and weak sides of such models. This knowledge was in turn applied during the design of a new benchmarking process model fit for project management processes.

Applying findings from the evaluation of the existing models, the steps for a new benchmarking process was developed through a transformation process of a selected existing model. A graphical representation for the benchmarking process was developed through a combination of a creative session and studies of different categories of existing graphical representations. This research suggest a new benchmarking process model, targeted to fit benchmarking of project management processes. The new benchmarking process model is shown in the figure below.



A numerical evaluation of the new benchmarking process model, showed that it scored highly throughout the entire set of evaluation criteria. Compared with existing models, the new benchmarking process model appeared superior for benchmarking of project management processes.

1. INTRODUCTION

This introduction chapter gives a description of the research program Project 2000, which the author has been involved in. Further, this chapter will introduce and briefly explain the terms “project”, “project management”, and “benchmarking”, with a focus on the view this dissertation will have on the terms.

1.1 ABOUT PROJECT 2000

Project 2000, in Norwegian abbreviated to PS 2000, is a national Norwegian research and development program within the field of project management. Project 2000 has a mission of identifying project management needs and improving the knowledge and implementation of project management in the Norwegian industry. The program will span over 5 years and go towards year 2000 with an expected budget of NOK 40 million (approx. US $5.5 million).

Participants

PS 2000, administratively based at the Norwegian University of Science and Technology (NTNU) in Trondheim, is a unique consortium gathering a wide variety of Norwegian businesses. It includes owners, designers, contractors, research institutions and the academic community who are committed to work together towards a common goal: the improvement of carrying out Norwegian “projects” from conception to final stages.

As of the beginning of 1997, the following participants were in the program:

- Norsk Hydro (energy, oil & gas, fertilizer, aluminum, magnesium, petrochemical products)
- Saga Petroleum (oil & gas)
- Statoil (oil & gas, petrochemical products)
- Statsbygg (state administration in building construction)
- Telenor (telecommunications)
- The Norwegian Defense (air force, army, navy, and more)
- SIEMENS (electronics)
- Kværner (oil and gas)
- The Swedish Defense
- One Building and Construction group
- One Information Technology group
- One Consultancy group

The building and construction group consists of two owner, two contractor, and four consultant engineering firms. These are respectively:

- Mustad Eiendom, and Byggherreforeningen;

- AS Anlegg, and Statkraft Anlegg; and
- Grøner AS, Berdal Strømme, IGP, and OPAK.

The Information Technology group consists of four companies:
- TerraMar, IFS, Bull, and Cap Gemini.

The Consultancy group consists of four companies:
- TerraMar, West Soft, Metier Scandinavia, and Erstad & Lekven

The above adds up to 25 Project 2000 member organizations. New members or participants are continually considered and admitted to the program.

Vision

As a guide to the research program activities, Project 2000 has the following vision:

Improving the competitiveness of Norwegian industry, by developing competence in the fields of identifying, evaluating, planning, and executing projects

Project 2000 objectives

The main objectives of the research program are:

1. To develop a new generation of project management tools and implement these in industry and government administration.
2. To develop new knowledge and improve the participating industry's expertise in project management.
3. To establish a multi- disciplinary center of expertise in project management at an advanced international level at NTNU/SINTEF.

Ways of accomplishment

In order to reach these objectives, Project 2000 will divide its work into three undertakings as shown in Figure 1.1 below:

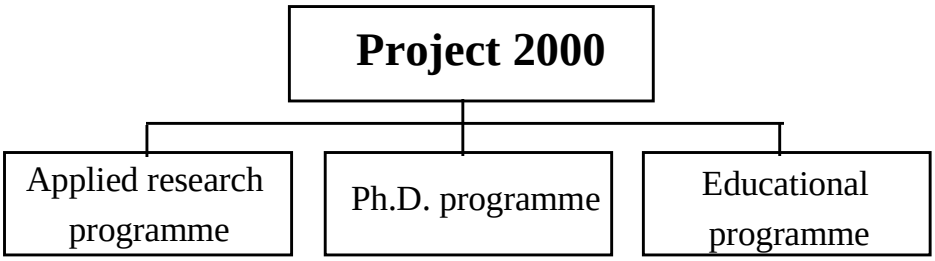


Figure 1.1 The three undertakings of Project 2000 (Kilde and Emhjellen, 1997).

The Applied Research Program

PS 2000's participants will select the research projects that are going to be carried out, deciding the research area, objectives and the use of resources linked to the projects. Figure 1.2 illustrates this process of selecting research projects.

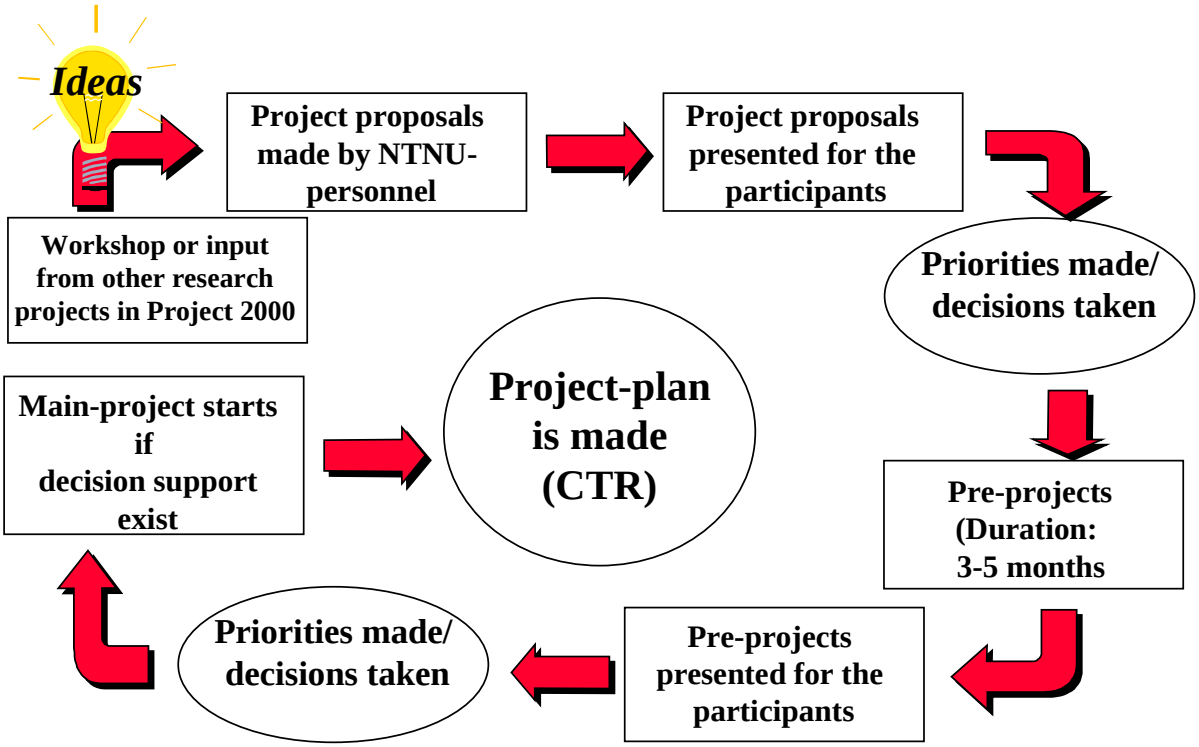


Figure 1.2 Illustration of how projects are established in Project 2000 (Kilde and Emhjellen, 1997).

The research program intends to carry out 8 main research projects within its duration (ending in year 2000). As of the beginning of 1997, *Project 2000* has 3 main projects and 8 sub-projects going on. These are illustrated in Figure 1.3.

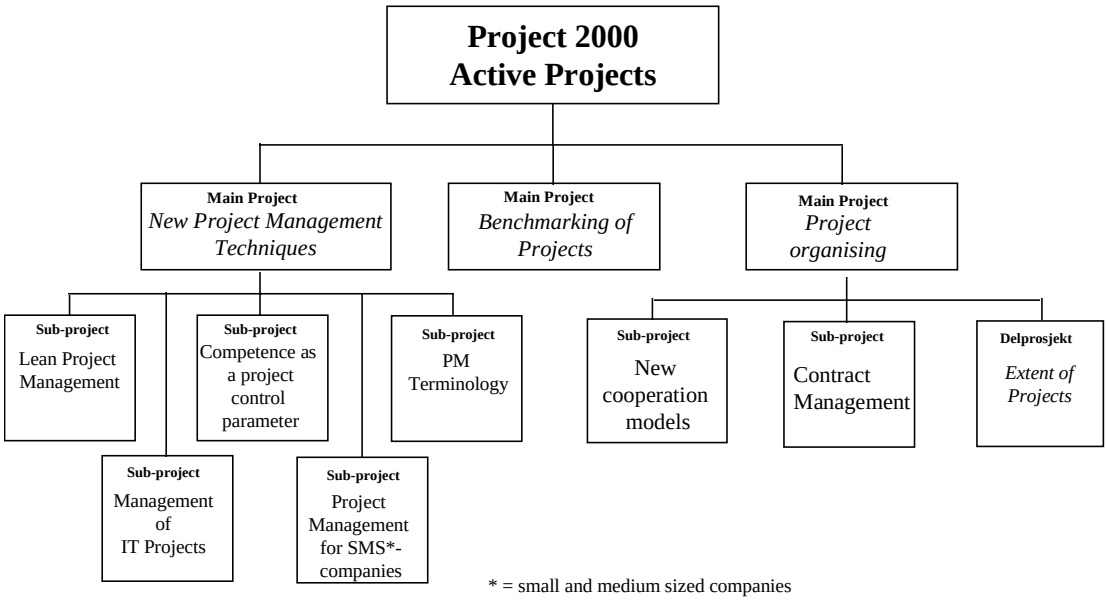


Figure 1.3 On-going Projects in Project 2000 (Kilde and Emhjellen, 1997).

The research projects finishes 1 of July each year, and terminates in a final report. New projects or projects that are carried on further, starts 1 of September each year. Please note the main project Benchmarking of Project Management, which this dissertation work is connected to. Figure 1.4 below shows the project history so far in Project 2000.

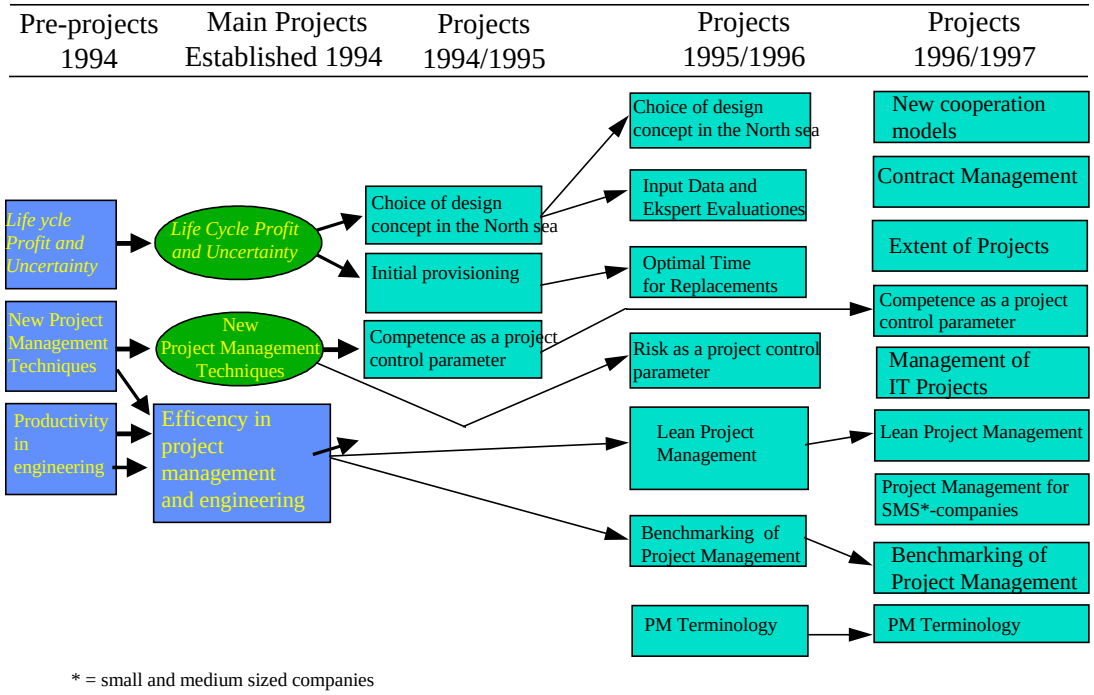


Figure 1.4 History of research projects in Project 2000 (Kilde and Emhjellen, 1997).

The Ph.D. Student Program

PS 2000 will finance as many as 12 Ph.D. students. All students are employed for 3 years and will be connected to a specific research project in their dissertation work. As previously mentioned, this dissertation work is connected to the main project "Benchmarking of Project Management". The students are trained and experienced project personnel returning to the university to get a Ph.D. degree. The experience requirement is meant to benefit the participants and enhance the quality of the research. As of January 1997, 10 Ph.D. students were connected to the program.

The Continuing Education Program

A continuing education program in Project Management with a total of 11 courses is developed for all interested parties from the industry. The courses are given intensively over 1 or 2 weeks with examinations and they carry regular credits from the Norwegian University of Science and Technology. Program participants in PS 2000 can register 3 students at each course, free of charge.

Conferences

A Project Management Forum will be arranged annually in September until year 2000. The objective of this forum is to gather expertise from both Norway and abroad for discussion and exchange of experiences.

More information about Project 2000

If you want more information about Project 2000, please contact the program coordinator Halvard S. Kilde at:

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1.2 PROJECT AND PROJECT MANAGEMENT

Project characteristics

Based on Gareis (1995), a project is a task that includes the following characteristics:

- temporary organization- an explicit organizational design and a definite start and ending time.
- complex - socially and technically (involves many parties and some inexperience with technology)
- important - it is set to perform an important task.
- risky - involves an amount of uncertainty and a chance that loss occurs.
- dynamic/flexible - adjusts when the project situation changes.
- unique (relatively) - it is unique, including a unique context and output (product or service). If a project is repeated the uniqueness is relatively reduced.
- goal determined - it has well defined goal(s) and direct its efforts against this goal.
- social system - with distinct structure and culture, differentiating itself from its environment.

Rolstadås and Klakegg (1995) bring in one more important project characteristic:

- non-operational - it differs from ongoing or routine operations in an organization.

Types of projects

One project may have very different content and size from another project. It may be appropriate to categorize the types of projects into the following 5 groups (Westhagen, 1994):

1. Product development and marketing projects
2. Technical construction and acquisition projects
3. System development projects (computer projects)
4. Organization development projects
5. Research and development projects

The 5 categories of projects very often illustrate different ways and culture of performing project management. However, the categories do often overlap.

Definitions of a project

It is hard to include all of the differences above into one general definition of a project. Therefore, numerous definitions exist ranging from long and complex to short and easy, all depending on its creator and its purpose. Some examples follows:

Rolstadås (1990):
A project is a task with a defined scope and purpose, and which is to be carried out once, and within a given budget and time schedule.

Statoil (1995b):
Project: The sum of the defined work tasks that shall be carried out by a temporary organization within a given time frame

International Standard Organization (ISO 10006, 1996):
Project: unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources.

The definition that will be used in this dissertation is from the Project Management Body of Knowledge (pmbok) by Project Management Institute (PMI, 1996):

> ***Project: A temporary endeavor undertaken to create a unique product or service.***

A definition of the term project that all project involved people agrees on, is hard or might even be impossible to make. However, there are obvious advantages to create a common terminology platform, for e.g. communication purposes. The *Project Management Body of Knowledge (pmbok)* by PMI(1996) is a step forward in standardizing the terminology in project management. The author of this dissertation therefore encourage its use and for the purpose of this dissertation, the above definition from *pmbok* will apply. The definition is simple, understandable, and do not exclude any task that is a project or include a task that is not a project. Even if the definition alone does not describe the whole complexity about what a project is, it is fine for the purpose of this dissertation.

What is Project Management? Definitions of project management

Project management is not an exact concept, meaning that there are variations in opinions on what it is. Similarly to *project*, numerous definitions describe project management.

According to the ISO standard: Quality Management - Guidelines to quality in project management (ISO 10006, 1996);
Project Management includes the planning, organizing, monitoring and controlling of all aspects of the project in a continuos process to achieve its internal and external objectives.

Kerzner (1995) states it differently:
Project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives (Kerzner, 1995)

Kerzner comments on that "relatively short-term objective" or the length of the project is varying and depending on industry and type of project.

Similarly to the term project, a definition or description of project management that all project involved people agrees on, is hard to make. The efforts in *Project Management Body of Knowledge (pmbok)* (PMI, 1996) to create a standardized terminology in project management, is the major reason for selecting it's definition for the use in this dissertation. The definition from *pmbok* is:

> ***Project Management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project***

PMI (1996) explains their definition further by stating:
Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among:

- *Scope, time, cost, and quality.*
- *Stakeholders with differing needs and expectations.*
- *Identified requirements (needs) and unidentified requirements (expectations).*

Westhagen (1994) divides project work into two parts, product-related work and project administration, as shown in Figure 1.5.

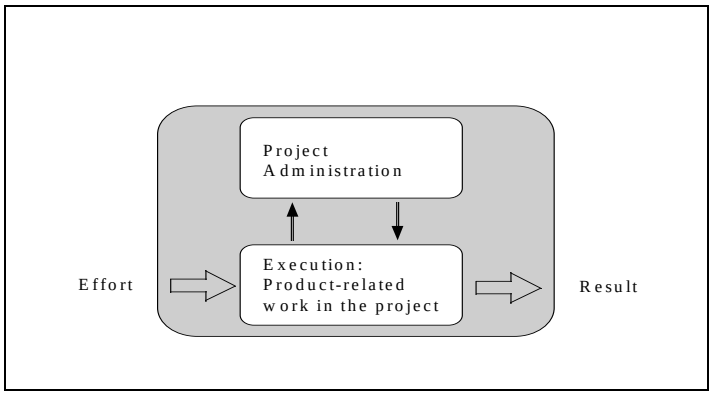


Figure 1.5. Project work (Westhagen, 1994)

This separation of project work into a general project administration part and a product related part, is important when the focus is on project management only. This separation is an important issue in this dissertation, and will be discussed further in the next chapter.

1.3 BENCHMARKING

General definitions of benchmarking

A vast number of publication exist on benchmarking with no agreed upon definition of the term *benchmarking*. Bendell, Boulter and Kelly (1993) writes: "Today, quite clearly, the term is ambiguous, woolly, a mystery. It appears to require great subtlety of understanding and clearly means different things to different people." The absence of a simple definition that is accepted as the real one, leads Carey (1995) to take the key points from a number of definitions and express them stepwise in the following clear terms:

Benchmarking:

- The methodology of examining in detail something your organization does (the performance measures and practices).
- Then comparing it with a similar process being performed more efficiently and effectively in your own or another organization.
- With the objective of finding ways of making significant improvements to your own process.

The term benchmarking has often been mistaken to be a mere comparison of key performance figures, and the author of this dissertation wants to emphasize that benchmarking involves more. A number of publications, e.g. Andersen and Pettersen(1996); Bendell, Boulter and Kelly (1993); Carey(1995), points out that benchmarking is not just about the comparison of key figures like financial performance or other high level attributes, as it has often been mistaken to be. Benchmarking has a focus on improvement, in understanding *why* there is a difference in performance and *how* one go about to improve. In Bendell, Boulter and Kelly's (1995) opinion, benchmarking is a natural development of the desire to improve and the process of improvement: "As well as looking internally, one looks for ideas to "borrow" or "steal" from those that are doing better, even perhaps in one very specific aspect."

Examples of some benchmarking definitions are shown below:

Benchmarking is the search for industry best practices that lead to superior performance (Camp, 1989)

Benchmarking is the process of continuously comparing and measuring an organization with business leaders anywhere in the world to gain information which will help the organization take action to improve its performance (American Productivity & Quality Center, 1993).

Measuring and comparing an organization against business leaders (Rolstadås ed., 1995).

The process of continuously measuring and comparing one's business processes against comparable processes in leading organizations to obtain information that will help the organization identify and implement improvements (Andersen and Pettersen, 1996)

The definition by Camp is an "original" one, while Camp's book was the first publication on the topic of benchmarking. The definition of benchmarking that best meet the above mentioned aspects of benchmarking, is by this authors opinion the latter by Andersen and Pettersen. There are two reasons for this. First, the definition specifically emphasize improvement as a goal of benchmarking. Second, the definition emphasize benchmarking to focus on processes, rather than just performance.

However, all the above definitions comes from production oriented organizations or individuals. This dissertation is concerned about benchmarking in the project environment, specifically benchmarking of project management. Only two definitions of benchmarking that come from project environments were discovered during this study:

A systematic process of measuring one's performance against results from recognized leaders for the purpose of determining best practices that leads to superior performance when adapted and implemented (CII, 1996a).

The activity of comparing context, processes, strategies and outputs across firms/projects in order to identify the best practices and to evaluate one's position with respect to them (IMEC, 1995)

None of these two definitions specify a improvement and process focus, although the latter mention processes. They do not either focus on project management. A definition for benchmarking of project management that focuses on improvement and processes was to be made for the purpose of this dissertation. The definition may also be for the use of others that wish to focus on benchmarking of project management. By taking appropriate parts from the definitions of CII and Andersen and Pettersen above, the following general definition of benchmarking was developed and will apply for this dissertation:

> ***Benchmarking is a systematic process of measuring one's (project management) processes against comparable processes with recognized***

leaders, in order to obtain information that will help the organization to identify and implement improvements.

Types of Benchmarking

Literature shows no consensus on the types of benchmarking, but have instead created several different words to define the various types. Carey (1995) writes." To someone new to the subject it would seem that there are at least 20 variations of Benchmarking, and to make it even more confusing, there are no common definition when comparing different books or articles." Lema and Price (1995) supports that there is such a confusion. They found that a number of authors seemed to agree on 4 different types (Internal, Competitive, Functional and Generic benchmarking), but found surprisingly that there were no agreement on the meaning of each type. Until a general agreed definition of benchmarking and definitions of types of benchmarking are developed, it is necessary for every publication to define or describe its perception.

For the purpose of this dissertation, the types of benchmarking defined by Andersen and Pettersen (1996) will be used. They split the types of benchmarking into two categories, defined by what is compared and whom it is compared against:

1) Compare what?

- *Performance benchmarking*: comparison of performance measures(often financial, but also operational) for the purpose of determine how good one's own company is compared to others
- *Process benchmarking*: comparison of methods and practices for performing business processes, for the purpose of learning from the best to improve one's own processes.
- *Strategic benchmarking*: comparison of the strategic choices and dispositions made by other companies, for the purpose of collecting information to improve one's own strategic planning and positioning.

2) Compare against whom?

- *Internal benchmarking*: comparison between departments, units, subsidiaries, or countries within the same company or organization.
- *Competitive benchmarking*: direct comparison of own performance/results against the best real competitors, i.e., that manufacture the same product or deliver the same service.
- *Functional benchmarking*: comparison of processes or functions against non-competitor companies within the same industry or technological area.
- *Generic benchmarking*: comparison of own processes against the best processes around, regardless of industry.

To illustrate their recommendations in combining the types of benchmarking, Andersen and Pettersen (1996) made a matrix shown in Figure 1.6.

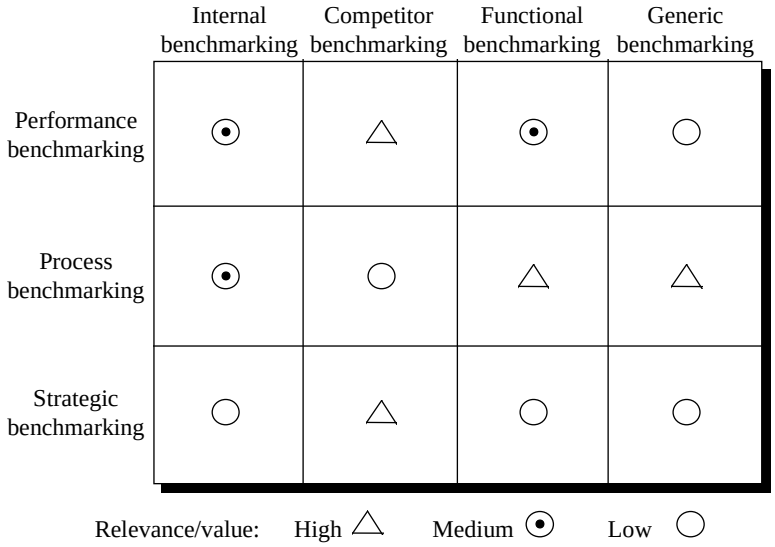


Figure 1.6 Recommended combinations of types of benchmarking from Andersen and Pettersen (1996)

Andersen and Pettersen (1996) states that functional and generic benchmarking produce the highest value when combined with process benchmarking. In relation to earlier discussion on what benchmarking is, process benchmarking seems to be the type of benchmarking that closest meet a general understanding of the concept. Early use of benchmarking (by e.g. Xerox) had a focus on performance benchmarking, which is necessary to find performance gaps. "Later, one realized that too much focus on performance measures gives little information about how to improve or close the gap to the partner. If learning, motivation, and improvement are to be the result of a benchmarking study, it requires that the causes for the performance gap are the focus of attention." For improvement, the processes behind the performance need also to be analyzed (process benchmarking).

As already touched upon, this dissertation will take the advice of past researchers and focus on process benchmarking, e.g. benchmarking of project management processes, in order to bring benchmarking closer to it's full potential. There are also other reasons to focus on project management processes that will be brought up in the next chapters.

2. DISSERTATION BACKGROUND

The overall dissertation objective is to improve the adaption of benchmarking to project management. This chapter gives a background and rationale for the dissertation topic, by giving an overview of existing research and identified problem areas for benchmarking in project environments. The chapter will further discuss and give the background for the assumption that project management processes should be the focus, when benchmarking is done on project management.

2.1 THE DISSERTATION RATIONALE

The background or rationale for the dissertation topic is that benchmarking was created in the production(manufacturing) environment and is not yet fully adapted to the project environment. Some researchers are even pessimistic about the use of benchmarking in a project environment. In his book on Total Quality in Construction Projects, Hellard (1993) strongly encourages the use of Total Quality Management (TQM) philosophy in the oldest project environment that exists, i.e. construction. However, about the prospects of using benchmarking in the same environment Hellard writes: "...by the nature of the construction industry, with its essentially project-based activities in different locations, the concept and principles of benchmarking are difficult to apply, and the lessons to be learnt more difficult to deduce. The concept of benchmarking against best practice is an excellent one. However, ...the author regrettably cannot see how the principle can be applied with benefit to most companies operating in the construction industry."

Hellard gives a very pessimistic view of benchmarking in the project environment. Others do not share this pessimism about using benchmarking in projects. A survey sent to Houston Business Roundtable members, reflected a strong interest in benchmarking within the engineering-procurement-construction community, where 90% of respondents stated the willingness to share data and modify existing data-collection procedures to provide uniformity in the way activities are measured across companies (Fischer, Miertschin and Pollock, 1995). Fisher and co-writers concludes in their article that benchmarking is new to the construction industry, but a so powerful tool that you cannot afford not to use it and further explore it.

The author of this dissertation share the opinion that benchmarking has the potential of becoming such a good tool for improvement in the project industry, that it must be further explored. Many companies and organizations are already researching and exploring the possibilities of benchmarking in the project environment. Examples of literature/research that show work in benchmarking of projects are: NORSOK(1995), Statoil (Andersen and Pettersen, 1995), Construction Industry Institute (CII, 1996a and CII, 1997), International Management of Engineering and Construction and Project 2000 (IMEC, 1995; IMEC 1996; and Andersen and Millar, 1996). Some of this

literature will be discussed in later sections of this dissertation. For now, just a short overview of the focus of current benchmarking work of projects will be given.

Benchmarking and measuring of high level attributes (like financial performance) in a project is commonly done. Sandberg (1996) of Statoil see this high level type of performance benchmarking as a wrong use of benchmarking, and that some organizations see benchmarking as a way to prove that they are world champions. As mentioned earlier, the intention of doing benchmarking should be improvement and not such a predetermined comparison of high attribute measures.

Due to the wanted improvement focus of benchmarking from most people with an interest in benchmarking of projects, considerate efforts are done to bring benchmarking to a lower project level. For instance have Construction Industry Institute defined performance measures (metrics) for different project phases, and are then able to use benchmarking for meaningful suggestions for improving the execution of projects to its members (see chapter 6 for more about CII benchmarking).

Another example is NORSOK(1995) which have come one step below the high attribute figures and measures key figures at a lower level, like financial and time-wise performance for different phases of Norwegian North Sea Oil & Gas exploration projects (see chapter 6). These key figures are compared with similar figures from projects in other parts of the world. NORSOK are thus able to evaluate various type of performances, that can help to set new goals and is the first step towards improvement. However, with the focus on performance only, it is hard for the NORSOK study to tell *why* there are differences in performance and *how* one should go by to improve. Again, to fully utilize the potential of benchmarking for improvement, the focus should be on processes, i.e. process benchmarking (see comments by several researchers in previous chapter). None of the two examples of project benchmarking mentioned above, have had such a focus that it can be said to be a process benchmarking.

The focus of this dissertation's research is on improvement of project management only, by using the technique *benchmarking*, and not the product related project work (see Figure 1.5. by Westhagen, 1994). The relation between project management and product related work in a project, will be discussed further in the coming sections of this chapter. The above mentioned examples of benchmarking do not directly focus on how to improve project management, but rather the project as a whole.

Only one - 1- publication was encountered that shows the actual use of benchmarking to improve project management directly. This publication is a report from British Columbia Hydro that contracted to Haddon Jackson Associates to organize and conduct a benchmarking study of project management practices in electric utilities (Brunner, McLeod and Laliberte, 1995).

Brunner et. al. sought to identify policies and practices of project management that impact performance. The basic concept of their benchmarking comparisons was to

relate the cost of providing project management to the benefit of the service. They write: "...there is a performance tradeoff that management must make between costs of providing project management services and the level of service, in terms of overall project cost and schedule performance, that the function provides. In other words, ...the more you spend on project management the more you are likely to receive in terms of overall project benefits. The study sought to identify those companies who have found ways to significantly reduce project management costs relative to the other companies, while maintaining a higher than average service level."

Their study's conclusions were:

- Increasing the sophistication of project management is a wise investment.
- Project managers in companies with specialized project management organizations handled more projects at the same time.
- Companies were more likely to meet cost targets than schedule targets.
- The engineering function is the least cost and schedule conscious.
- Introducing an appropriate level of engineering and construction contracting into the project has a beneficial effect on cost performance. (Between 30-70% of contracting in engineering is the optimum. Having more or less makes the cost performance drop. In construction, project cost performance was maximized when greater than 60% of the construction was contracted.)
- Project management organizations do not monitor their overall performance very well.

Although this study is very interesting and may help in improving project management, the focus is at a too high level of project management in order to use the full potential of benchmarking. This is partially recognized by Brunner, McLeod and Laliberte:

"Although not yet established, the corporation recognizes the need to develop measures relating to the project management process in order to monitor and improve the level of performance in completing projects."

This request about measures for project management processes is interesting and correspond to the view of the author of this dissertation. Next section in this chapter will discuss the measuring of project management further.

Researchers are aware of that more work need to be done to use benchmarking in the project environment to its full potential. In addition to above discussed work that needs to be done, researchers have also discussed other problems. Lema and Price (1995) states four problems that research has to address within the TQM framework in order to find the full potential for benchmarking in the construction industry:

1. Identify and prioritize areas with potentials for performance improvement, i.e. what areas should benchmarking focus on?

2. Identify sources of best performance and best practices, i.e. who can we compare against?
3. Set out a methodology for adapting and improving the best practices in an organization for quality and productivity improvement, i.e. what methodology can we follow to incorporate new knowledge and improve?
4. Develop a framework for how to compare performances and set targets in an organization, both within the industry and outside the industry, i.e. internal and external benchmarking.

Many of the above problems are complex and even hard to comprehend, and can not easily be addressed by company benchmarkers or researchers. It is therefore wise to target and address the problems that researchers believe are the most urgent or pertinent ones. Swanson (1993) writes: "For most organizations, the decision to benchmark is not hard to make, but the decisions on which practices to benchmark and which performance measures to use are difficult. There is sufficient literature suggesting that benchmarking should focus on critical areas first, but the literature doesn't provide practical tools to help the practitioner select appropriate benchmark subjects and measures."

Sandberg (1996) agrees with Swanson's opinion. "The number 1 problem in benchmarking today is that no one are able to define what one wish to focus on." Jakobsen (1993a) states the same problems in other words "the greatest challenge in connection with benchmarking of project management, is in determining what areas of project management that are to be benchmarked".

Thus, the two most pertinent or prioritized problems these researchers focus on, can with the focus of this dissertation be summarized as:

1. to decide what areas of project management to benchmark.
2. to decide what to measure, i.e. define metrics.

Andersen (1995b) bring the discussion of these two problems one step further, by strongly encouraging the process focus as part of the solution for benchmarking to be fit for project management. Viewed from his production or manufacturing environment, but after being involved in studies of the potentials of benchmarking in the project environment, Andersen (1995b) claimed that there are 3 major problems that needs to be addressed for benchmarking to work to its full potential for project management:

1. project management have not traditionally been process oriented like the production environment. The processes of project management need to be defined and preferable described with the relation to each other.
2. measures or metrics for these project management processes need to be suggested.

3. there is a need for a benchmarking process model adapted to the project environment, i.e. a new step-by step plan that are followed when the benchmarking is actually executed. The existing models are made for the production environment and needs to be adjusted.

There has been some development since 1995, especially in the matter of project management processes, that will be brought up later. The author of this dissertation agrees with Andersen that the process focus is part of the solution to make benchmarking work for project management. However, the focus on project management and its processes requires a fundamental discussion of what a project and its different components really are.

2.2 THE BASIC PROBLEM OF VIEWING AND MEASURING PROJECT MANAGEMENT

If one were to benchmark (and improve) project management only, and preferably leave out the other parts of the project, how could one go by to do this? The basic problem is to figure out how to separate project management from the rest of the project, in order to be able to measure and compare this project management with project management elsewhere. In other words, it is about conceptualizing where project management belong in the total project situation, and where an effort of measuring and improvement should be focused.

If one want to evaluate and measure project management, how can this be done? One way to measure project management is simply to ask a number of people knowledgeable of the project and project management in consideration. You can ask to such a specific level you want, and sometimes this is the best thing you got. This type of measuring is subjective. However, subjective measures are just as good as objective if you have structured them and you have enough of them (Tucker, 1996). Still, if possible, an objective way of measuring is wanted that provides a framework for which area of project management to select.

Based on ideas gotten from Westhagen (1994), Johansen et. al. (1995) and PMI (1996), Figure 2.1 below is developed to illustrate where the author of this dissertation see project management belong in relation to other project components in the total project situation.

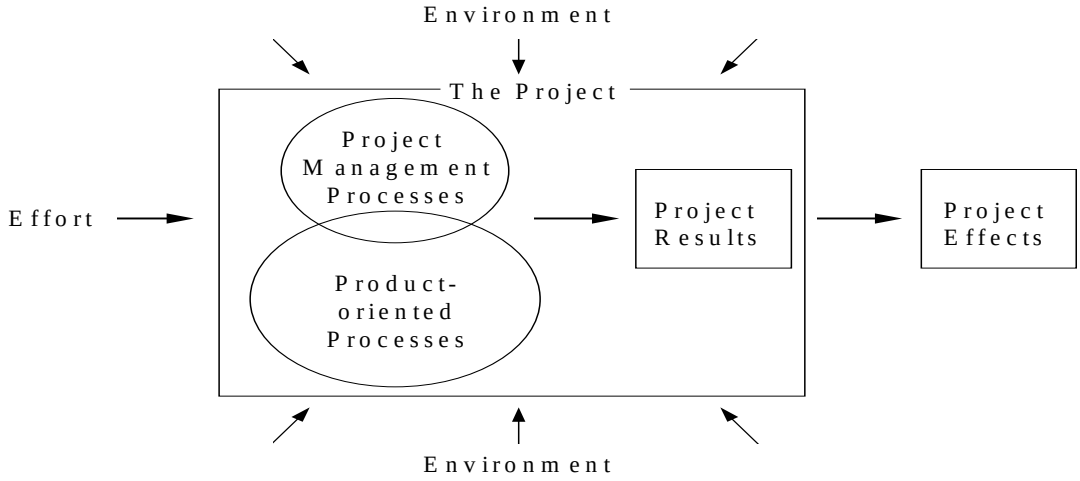


Figure 2.1 Illustration of the relation between the project processes, project results and project effects (not drawn to scale).

The figure shows that the project consist of both project management processes and product oriented processes. Project management processes are *processes concerned with describing and organizing the work of the project*, whereas the product-oriented processes are *processes concerned with specifying and creating the project product* (PMI, 1996). Within the influence of the project environment/context and the constraints of organizational efforts or inputs like resources, these processes combined brings about the project results. The project result is the immediate results or outputs of a project at its finishing point. The project and its result thereafter brings about the project effects, which is short term and long term influence the project has on its environment.

Assuming that there exists a generally accepted set of project management processes, Figure 2.1 with its process focus could be a way of separating project management and provide a framework for what areas of project management that could be measured and compared across different projects. However, before such a conclusion or assumption is made, a further discussion on measuring project management is required.

Project management overall does not have a result by itself, but have a result in conjunction with the product oriented work. Is it then possible to measure/evaluate key figures of the project result (e.g. financial and other high level attributes), compare it with project results from other projects, and draw conclusions on how project management was performed? Probably you get some answers, but what you actually do then is to assume a correlation between project management and project results (see Figure 2.2).

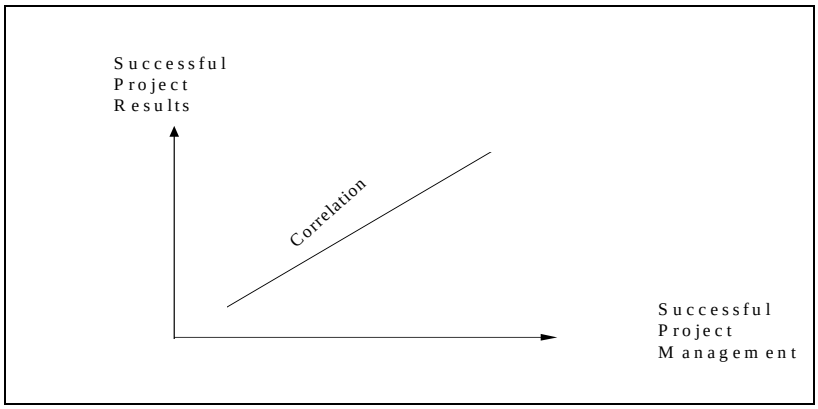


Figure 2.2. Are there a correlation between successful project management and successful Project Results?

This correlation is questionable, since the work that bring about the project results are both project management work and product oriented work. It is hard to tell what makes up the project management contribution in the combined project results.

Another factor that complicates the comparison of key figures from project results of one project to another, is that the work in every project are done within its unique project environment, e.g. political, geographical and business context. These are all factors that are outside the control of the project and project management, but they have to be dealt with and they influence the project results.

In addition, an evaluation or measure of project management performance based on the project results will be complicated by the fact that the project and both project management and product oriented work will be constrained to the effort or the input of resources from the involved organization(s). If this effort or input of resources is high (e.g. the allocation of financial resources is high), the project results are more likely to be good. If the effort is low, the performance of the project is similarly more likely to be low.

The previous chapter mentioned another argument against viewing and measuring key figures of the project result and compare these with key figures from other projects, in order to improve (project management). A number of authors (Camp, 1989; Bendell, Boulter and Kelly, 1993; Andersen and Pettersen, 1996; and Carey, 1995), have pointed out that such a measuring and comparison will not tell much either on *why* there is a difference in performance or *how* you can go by to improve. In other words, measuring key figures of the project result, will not make you able to improve. The improvement is a requirement in order to do a complete benchmarking of project management.

A paper by Munns and Bjeirmi (1996) that discusses the difference between project success and project management success, brings another dimension to the problem of measuring key figures of the project result or not. Their paper illustrate quite well the difference in the scope of project management compared to the rest of the project.

Munns and Bjeirmi state that there are projects where the project results have been perceived to be a disaster, but the project management have been perceived to be good. Conversely, there are projects where the results have been perceived good, but the project management have been perceived to be a disaster. In other words, the perception of how well project management was, can be the opposite of what the perception of how well the project result was.

Munns and Bjeirmi claim this to be so due to the different scope of project management success and scope of project success (see Figure 2.3).

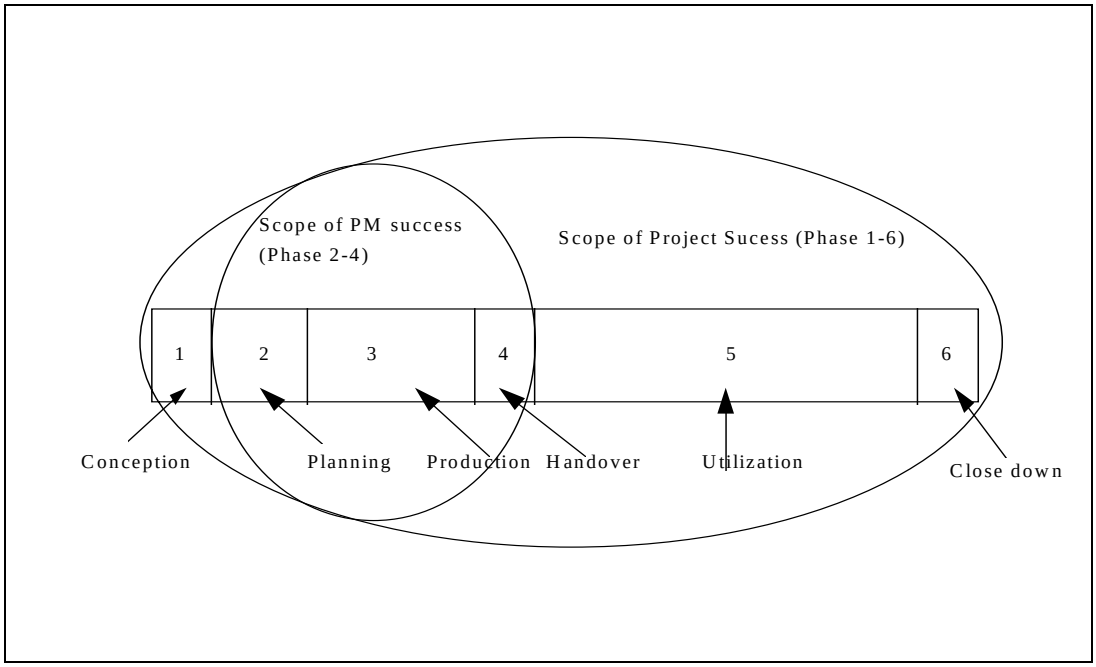


Figure 2.3. Scope of Project Management success and Scope of Project Success (Munns and Bjeirmi, 1996)

The figure shows that project management that is in function (or has its scope of success) in the planning, production and hand-over phases of a project has a limited power to influence the whole project with its scope of success from the beginning of the conception phase to the end of the close down phase. Munns and Bjeirmi states:

> *... one must always bear in mind that successful project management techniques will contribute to the achievement of the projects, but project management will not stop a project from failing to succeed. The right project will succeed almost without the success of project management, but successful project management could enhance its success.*

The immediate though after reading Munns and Bjeirmi's research results could be to ask: why bother with project management when it has such a limited scope in the project? It is therefore important to focus on the last part of the quoting, i.e. that successful project management will enhance the success of the project.

In sum, the arguments against measuring the project results only in order to measure project management were many. Such a measuring is not recommended, which may be obvious to many researchers. However, this has not been clear to all researchers. Jakobsen (1993a and b) wrote a master thesis on what he called "Benchmarking of Project Management Performance in North Sea Oil and gas Field development Projects". In his objective section, he wrote:
"... the project management performance will be measured by measuring the performance of the project. A successful project indicates that the project management has also been successful."

Based on the argumentation above, the author disagrees with this statement or assumption in Jakobsen's work. The success of a project do not necessary equals successful project management.

Well, if measuring the project results only was not the answer in order to evaluate and improve project management, what other options are there? It looks like one has to bring the problem one step down. One possibility would be to break the project into different phases and look at the performance for each phase. More complete information of the project is then gained. However, you would then consider the performance of both project management and product oriented work. Project Management or the contribution of project management that is the focus of this discussion and dissertation, would not be separated from the product oriented work of the project. In addition, measuring key figures of phases will give information on phase performance when compared to key figures from phases of other projects, but again, it will not give much information on why there is a difference and how to improve.

It is probably not possible to measure project management completely alone, because it is interrelated with the rest of the project. Figure 2.1 illustrates this interrelation. However, the point is to separate it as much as possible. The believed best approach in order to measure and evaluate project management with the objective of comparing these measures elsewhere and find ways to improve, i.e. to do a benchmarking, is to look directly on specific project management processes. One can evaluate and measure the project management process in question and compare it with same or similar project management process elsewhere. Different measures on e.g. the effectiveness and efficiency of this process can be gathered that tells you something about performance, why there is a difference, and how to improve. The metrics part of this dissertation, part 2, has a further discussion on measures and metrics.

What influence do the specific project management process have on the project result? In order to move down to the process level of project management, a decision or assumption has to be decided upon with regard to this question. With reference to earlier discussion in this dissertation section and Munns and Bjeirmi's discussion on project management's influence on the project result, the following assumption, that probably holds true is made:

Relative to their performance, project management processes will have an improving or worsening impact on the project result (see Figure 2.4).

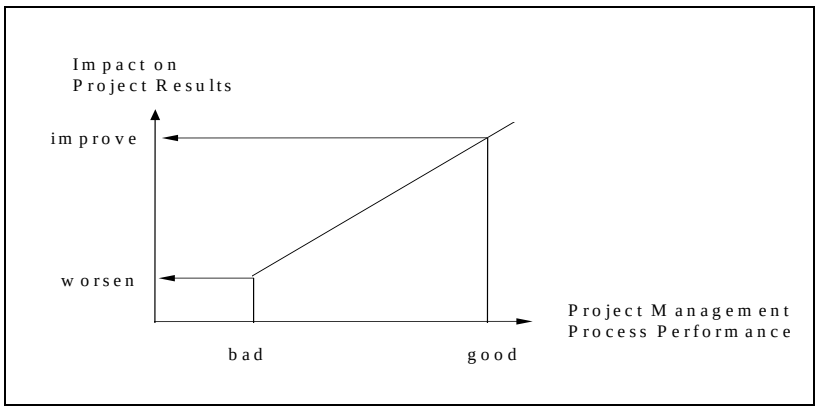


Figure 2.4 Assumed relation between Project management Processes and the Project Results.

The figure tries to illustrate that good performed project management processes improves or makes the project results better. Likewise, bad performed project management processes have a negative impact on or makes the project results worse. When the project management process performance is quite in between good and bad, the likely effect this process have on the project result is quite neutral.

2.3 CHAPTER SUMMARY AND CONCLUSION

This chapter has showed that only one encountered study had targeted project management only in its benchmarking. All encountered existing benchmarking work in the project environment, have had a focus that is to general to reach down to the process level where benchmarking can be used to it's full potential. Researchers have pointed out several problems that needs to be addressed before benchmarking can work properly in the project environment and for project management. These problems and the addressing of them, will be further discussed in the next chapter.

It is important to know that project success do not necessary equal project management success. The necessary basic understanding that project management can not be measured by the project results alone, may look quite obvious to the reader. However, this is not so obvious to all researchers. There are examples in literature where the measuring of the project result was set equal to the measuring of project management.

The latter section has argued for moving project management benchmarking efforts down to a process level for two major reasons:

- in order to target and measure project management in its purest form.
- in order to be able to do a complete benchmarking, i.e. to include the important improvement part. The improvement part of benchmarking includes to be able to tell why there is difference in performance and how to improve.

This dissertation will from now on assume that to concentrate project management benchmarking efforts on project management processes is the right thing to do. Further, this dissertation assume that the relations between the project elements in Figure 2.1 are correct.

3. THE PROJECT DISSERTATION

This chapter will state the purpose of the dissertation research. Further, the managing of "The Project Dissertation" will be presented along with a presentation of the research methodology.

3.1 THE DISSERTATION PURPOSE

The overall purpose of this dissertation is to better the adaption of benchmarking to the project environment with a focus on project management, so an organization or a group of organizations better can use benchmarking for improving their project management.

More specifically, the previous chapter (section 2.1) brought up several problems that needs to be addressed concerning benchmarking in the project environment and benchmarking of project management. Of the discussed problems, the initial problems that this research were to address were the following:

1. To define the processes of project management and preferably describe them in relation to each other.
2. Bring further the problem of finding what areas of project management, i.e. which processes, the technique benchmarking should focus on.
3. To suggest measures or metrics for the project management processes.
4. Look into existing benchmarking process models, i.e. step by step structures to guide in the execution of benchmarking, and if necessary, suggest a new model that is fit for benchmarking of project management processes.

The reason for initially choosing these problem areas to work on, were because these problem areas were considered by the author of this dissertation to be of a fundamental character and need to be brought forward before benchmarking can be used properly on project management. This opinion were based on previous researchers comments about the problems of benchmarking, which were brought up in Section 2.1: The Dissertation Rationale. The above four research problems are further discussion below.

The first research problem was the most obvious one to choose. Based on the assumption that project management processes should be the focus of benchmarking, the processes of project management needed to be defined and described, before any further action could be done in the matter of adapting benchmarking to project management.

An attempt to address research problem number two was an obvious selection as well, while several researchers said that deciding on what to benchmark was the most pertinent problem with respect to benchmarking of project management (refer to comments in Section 2.1 by e.g. Swanson, Sandberg, and Jakobsen). However, different projects may vary in which project management processes that have a need of improvement, due to e.g. different types of projects. In order to reduce this variation, it was for this dissertation work decided to focus on construction projects only, and see if it was possible to find or indicate strong or weak areas of project management in this type of projects. Such an indication can be an aid in deciding areas of project management that benchmarking and improvement efforts should focus on.

The third problem about defining measures / metrics was also mentioned by several researcher to have a top priority for making benchmarking work for project management. It is necessary to define some measures / metrics for project management, to be able to improve and benchmark project management. The problem fitted quite well in the context of this research, and with this dissertation research's focus on project management processes, the problem became to identify measures / metrics to project management processes. These metrics will however not be universal metrics that can be copied and used directly. An organization interested in doing benchmarking needs to define their own measures / metrics for their own project management processes. The metrics that this research will suggest, are meant to be somewhere to look and to get ideas, and needs to be adjusted or adapted to the project management processes of the organization in question. The author of this dissertation is of the opinion that to make suggestions for some measures /metrics where interested people could look up to get ideas for own use, are the best one can hope for. No all-covering and universal metrics can be made for project management processes, while all organizations have their own practices and defines their project management processes differently.

Research problem number four about benchmarking process models, i.e. a step by step plan to guide in the execution of benchmarking, is necessary to address to create a framework or plan for how benchmarking of project management processes can be executed. The problem was brought up in the dissertation rationale (section 2.1) by e.g. Lema and Price (1995), and Andersen(1995). Problem four makes an overhead structure to where the findings to the other problems may fit in. Existing benchmarking process models have been developed in the production environment, and it may be that they do not fit in the project environment for project management processes. This research will attempt to discuss potential shortcomings of existing benchmarking process models, and if necessary, attempt to develop a new benchmarking process model fit for benchmarking of project management processes.

Going back to the first problem, the work on identifying previous research on defining project management processes started in the end of 1995. At that point, no encountered publications had described a set of project management processes properly. After starting to do a research to define project management processes myself, two publications were encountered in 1996 that independently described project management processes. In the order they were encountered, the publications were *ISO 10006 Quality Management - Guidelines to quality in project management* (ISO 10006, 1996) and *A Guide to The Project Management Body of Knowledge* by Project Management Institute (PMI, 1996). The next chapter will present these publications' set of project management processes. After viewing these two publications, one of the sets of project management processes was decided to go further with and use in this dissertation research . However, even if recognized project managers had contributed to the development of this document, it was decided to present the set of project management processes to experienced project personnel and ask for their opinion of how well they were. The reason for this opinion gathering, was the plan to use the set of project management processes further in this research. If the perceptions about the set of processes were bad, the set may not have been used as planned. If the perceptions were quite good, the research could build further on the set of processes and its defined project management processes. The perceptions of the set of project management processes were also believed to be of general interest among project management personnel, because the process focus is new to project management. Especially Norwegian project management personnel was believed to have an interest in the perceptions of such a set of processes, while no Norwegian literature encountered in this research had described or set focus on a set of project management processes.

After changing the initial four problems slightly, the four research problems this dissertation will try to address and bring closer to an answer were elaborated above and are summarized below.

The Dissertation Research Problems:

1. **Ask experienced project management personnel for their perception of the set of project management processes, which the author of this dissertation find to be the best of two existing sets.**
2. **Indicate strong and weak areas of project management for construction type of projects, in order to be able to aid in deciding what areas of project management, i.e. what processes, the technique benchmarking should focus on.**
3. **Suggest metrics for project management processes, that can be looked up and used as an aid for potential benchmarkers to**

define metrics for own project management processes. It is important to emphasize that the metrics this research is to identify, are not universal metrics, but needs to be adapted to the project management processes of the organization in question.

4. **Evaluate existing benchmarking process models' fitness for benchmarking of project management processes, and if necessary, suggest a new model targeted to fit for benchmarking of project management processes.**

Benefits of the dissertation research

If this dissertation research successfully address the above problems, the benefits would include the following:

The focus on improvement and benchmarking of project management processes and the increased knowledge about perceptions of project management processes, should lead to easier execution of future benchmarking studies of project management. The process focus should further bring the use of benchmarking closer to its full potentials for improvement.

A confirmation of a well perception of the chosen set of project management processes, would in general benefit all future research on the matter and specifically benefit this dissertation research. Much of the further dissertation work were to be based on the selected set of project management processes.

Even if both of the published sets were developed by recognized organizations, the process focus in project management is new. Confirming a well perception among experienced project management personnel both from USA and Norway, should carry weight for organizations in the beginning of defining and developing their own project management processes. Individual projects or organizations need to create their own project management processes for practical use, due to variations in projects and project management. Norwegian organizations should especially benefit from this part of the dissertation work, while no Norwegian literature was encountered with sets of project management processes. Even if some Norwegian organizations are well aware of publications in English, others are not. The dissertation could inform that there exist a set of project management processes in English that is well perceived and could be studied when defining their own processes.

No encountered work has explored the importance and performance of different areas and processes of project management. This research's exploration of importance and performance of project management processes can give indications of weak and strong areas of project management and indicate where to focus improvement efforts and benchmarking. Even if the attempt to

indicate such areas of project management was to be unsucessful, the attempt in itself could be learned from in future research attempts with similar objectives. The study can thus in any case, help future researchers and benchmarkers in their own attempts to identify areas for improvement and benchmarking.

This research's suggestion for metrics to project management processes, would aid potential benchmarkers in the future. With this research's lists of suggested metrics to project management processes, the potential benchmarkers would have a place to look for ideas when defining metrics for own project management processes. Today, there are no such a place to look.

The research's evaluation of the ability to existing benchmarking process models' fitness to guide in a benchmarking study of project management processes, would aid in understanding the pros and cons, and needs, for using a model in such environments. Furthermore, if none of the existing models seems to be fit, the development of a new model targeted to fit for benchmarking of project management processes would aid all people interested in benchmarking of projects and project management. The model would be a tool to guide in future benchmarking studies of project management processes.

Overall, the focus and discussions of this dissertation work would hopefully help to solve problems of fundamental character and bring the adaption of benchmarking to project management a major step forward. Further, the study may also bring an increased interest among project management personnel to benchmarking, and help set focus on improvement in their daily activities.

3.2 MANAGING THE PROJECT DISSERTATION

The following section on "the dissertation project" is used to portray the managing of the dissertation and to structure and understand its context. Ph.D. students at Extraordinariat Projektmanagement at Wirtschaftsuniversität Wien, Austria, portray their dissertations this way. I refer to the dissertation of Alexander Doujak (Doujak, 1991), and course material of Roland Gareis (Gareis, 1995).

The dissertation is viewed as a project with its unique characters, and need thus its own project management. The project management functions include project planning, controlling and assignment of responsibilities, in order to cope with the tasks to be performed, the schedule, the resources and costs, as well as coping with the project context. The Project Dissertation is a special project with its own unique characters, and the determination of its boundaries and context are the basis for the project management of it.

Project boundaries

Contents Dimension: See dissertation Rationale and Purpose (Sections 2.1 and 3.1)

Time Dimension:

- Start of dr. ing. /ph. d. study: May 1994.
- Start of dissertation work: October 23, 1995 (day of exam in last required course).
- End of dissertation work and ph.d. study: Fall semester 1997.
- Milestones: Required courses finished, Dissertation subject/topic decided, Project plan and concept made and accepted by supervisor, Interviews finished, Surveys finished, Draft developed, Supervisor feedback incorporated into draft, Dissertation report to printing and binding, Topic for trial presentation given, Trial presentation and Defense.

Cost Dimension:

- The Ph.D. candidate has a scholarship from Project 2000 from May 1, 1994 to September 1, 1997.
- Extra costs for travel and stay abroad was only partly covered by Project 2000. The candidate applied for available grants, and received enough to cover most of the expenses.

Social Dimension:

- Supervising Professor: Dr. Ing. Asbjørn Rolstadås, Professor
- Dr. ing. /Ph.D. Candidate: M.Sc. in Eng. Kjetil Emhjellen
- Discussion Partners: Bjørn Andersen, Agnar Johansen, Roland Gareis/Christian Sterrer and Richard Tucker/Kirk Morrow.
- Opponents: 3 opponents to the dissertation and the defense of it, will be decided shortly before defense.

Project Context

The professional context (Figure 3.1) illustrates the project surroundings that professionally have influenced the dissertation.

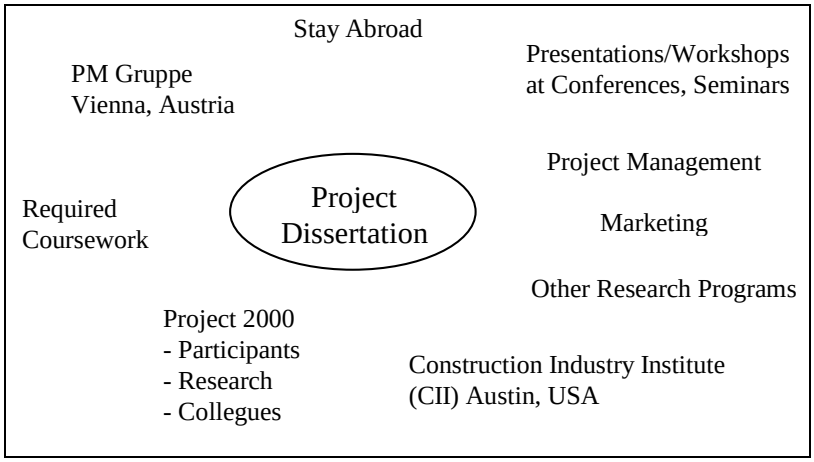


Figure 3.1 Professional Context to the Project "Dissertation"

The Project Dissertation was surrounded and influenced by more than the professional environment illustrated in the figure above. A *Project Environment Analysis (in German: Projektumweltanalyse)* was conducted to have as good as possible overview of the social environment that surrounded and influenced the Project Dissertation. Figure 3.2 illustrates The Project Dissertation and its environment of individuals and organizations.

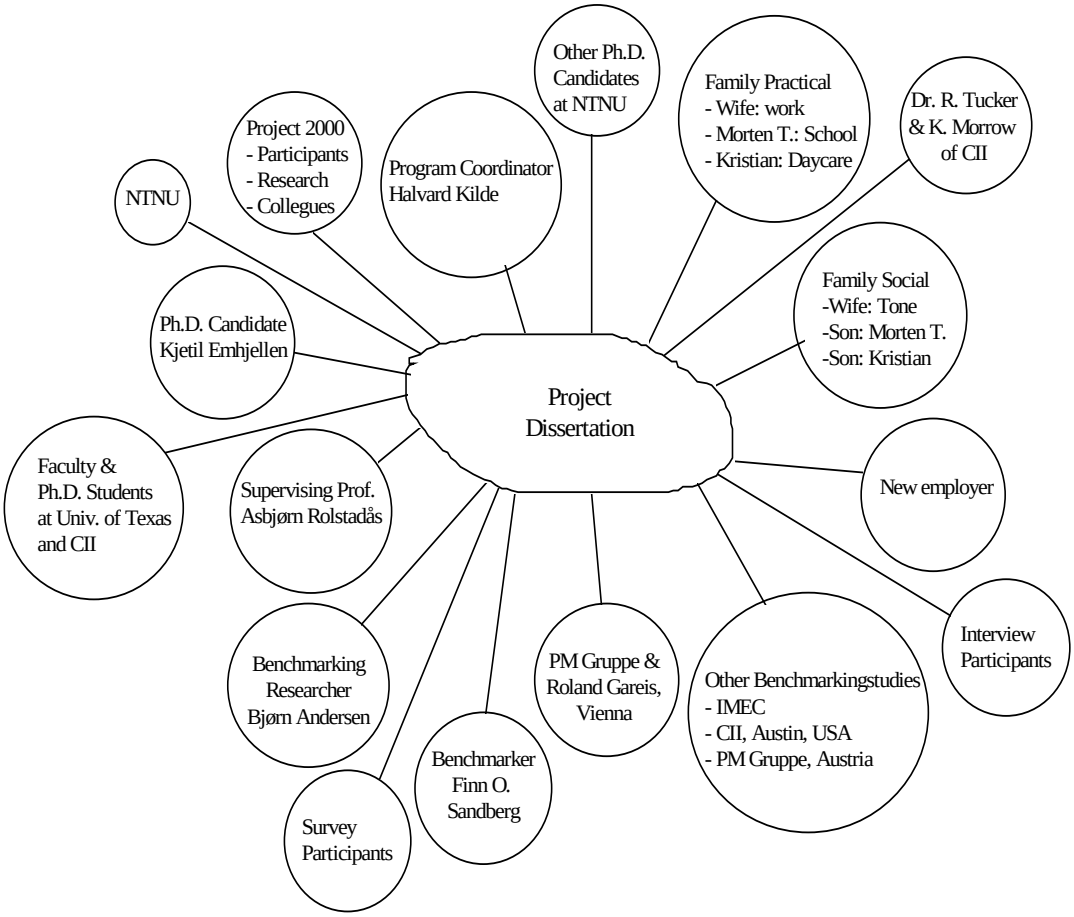


Figure 3.2 Project Environment to The Project Dissertation.

The time-wise context to The Project Dissertation is illustrated in Figure 3.3.

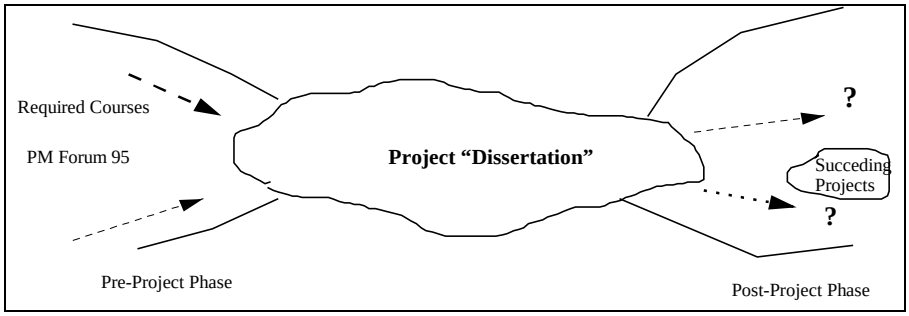
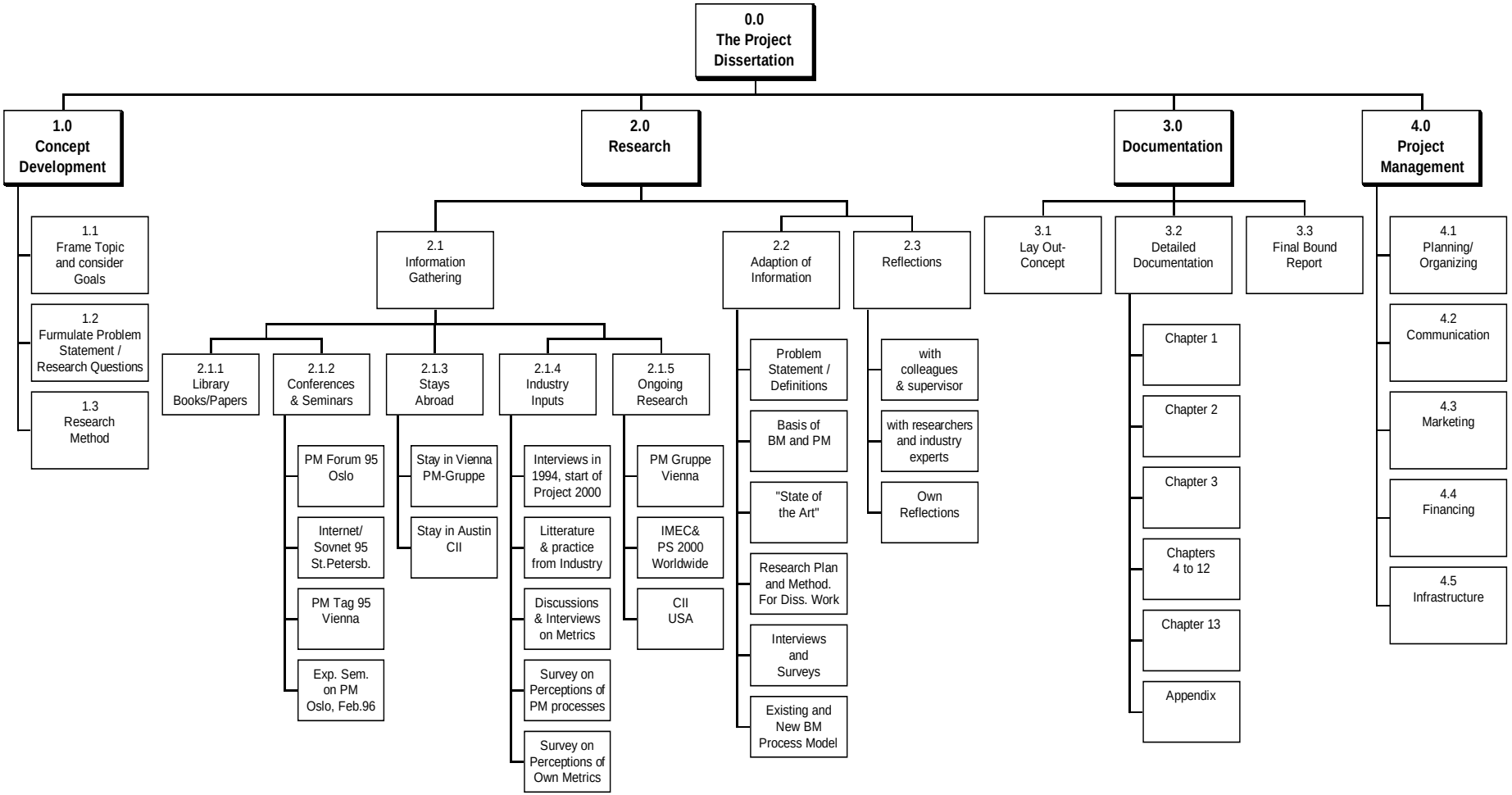


Figure 3.3: Time-wise Context to The Project Dissertation

Project Structure Plan (Managerial Structure)
A work breakdown structure for managerial use, called a Project Structure Plan, was made of The Project Dissertation and is shown in Figure 3.4.

Figure 3.4 Project Structure Plan for the Management of The Project Dissertation



3.3 RESEARCH METHOD

Purpose of research in general

Research serves many purposes. According to Babbie (1995): "Three of the most common and useful purposes are *exploration*, *description*, and *explanation*."

The three research purposes can be summarized as follows (Babbie, 1995):

- Exploration is the attempt to develop an initial, rough understanding of some phenomenon.
- Description is the precise measurement and reporting of the characteristics of some population or phenomenon under study.
- Explanation is the discovery and reporting of relationships among different aspects of the phenomenon under study. Whereas descriptive studies answer the question "What is so?" explanatory ones tend to answer the question "Why?"

Research design

Research design is an overview plan for how a research project is to be conducted. There are two fundamental different research approaches that can be said to be relevant to this dissertation work (Wilkinson, 1991; Babbie, 1995):

1. Deductive approach
2. Inductive approach

In deductive research, the researcher constructs a hypothesis and seek to test it to be true or not through observation of reality (Babbie, 1995). In other words, a hypothesis is established as a starting point, and is attempted verified or falsified through the research. Thus, the research reason from the unknown to the known. The method has been the fundament in the natural science for hundreds of years and has as a basis a confidence to an absolute and objective knowledge.

In inductive research, the researcher use observation of reality to reason from the specific and the known to the general and unknown (Wilkinson, 1991). Babbie (1995) explains it slightly different: through the inductive method by observing reality, the researcher seeks to discover patterns that may point to more-or-less universal principles. Inductive research has no starting point in a hypothesis, but usually starts with a vague and imprecise problem statement. The inductive approach can be viewed as quite the opposite of the deductive approach. When deductive research in direction reason from the unknown to the known, inductive research reason from the known to the unknown.

Within these two main approaches of research, the research design can be classified into two types, dependent on how one approaches the research problem. The research can be either of the two (Babbie, 1995; Johansen, 1995):

- quantitative
- qualitative

Quantitative research is based on a gathering of a few but comparable data, usually numbers, that are analyzed further. It is common to use one form of survey where the data is gathered from a representative population. Qualitative research is based on a gathering of larger multitudes of data, usually verbal information, that are hoped to throw light on the research problem. Andersen (1995) summarizes the two types of research designs as follows:

"Quantitative research is based on so-called hard information, usually expressed as numbers and by measuring reality. Qualitative observations consist of so-called soft information, expressed as verbal descriptions, often obtained by asking respondents for subjective opinions."

Research methodology for this study

Before any research can take place, the researcher needs a knowledge platform or understanding of the topic in question. This understanding is necessary to be able to state the research problem and to conduct the research. Laakso (1997) calls this understanding for preunderstanding, and defines it as: "Preunderstanding is researcher's knowledge, insights and experience before engaging in a research project."

According to the preunderstanding of this dissertation research, the research problem is stated as:

how can organizations be helped to use benchmarking for improving their project management?

After a certain amount of reading, thoughts, and discussions with knowledgeable people in project management and benchmarking, some introductory opinions about the problem were made and some assumptions made to be able to go on with the research (see Chapter 2). The overall research purpose became:

> ***to better the adaption of benchmarking to the project environment with a focus on project management, so an***

organization or a group of organizations better can use benchmarking for improving their project management.

Further, the specific research problems this dissertation were to look into became summarized as:

1. **Ask experienced project management personnel for their perception of a set of project management processes, which the author of this dissertation find to be the best of two existing sets.**
2. **Indicate strong and weak areas of project management for construction type of projects, in order to be able to aid in deciding what areas of project management, i.e. what processes, the technique benchmarking should focus on.**
3. **Suggest metrics for project management processes, that can be looked up and used as an aid for potential benchmarkers to define metrics for own project management processes. It is important to emphasize that the metrics this research is to identify, are not universal metrics, but needs to be adapted to the project management processes of the organization in question.**
4. **Evaluate existing benchmarking process models' fitness for benchmarking of project management processes, and if necessary, suggest a new model targeted to fit for benchmarking of project management processes.**

Concerning the three research purposes *exploration*, *description* and *explanation*, Babbie (1995) writes: "Although it is useful to distinguish the three purposes of research,...a given study can have more than one of these purposes-and most do."

This dissertation study also have elements of all three purposes, but exploratory study is the best overall portrayal of the dissertation research since it is conducted to explore a relatively new and unstudied topic. Babbie (1995) describe the following characteristics of an exploratory study:

- essential whenever a researcher is breaking new ground and almost always yield new insights into a topic of research.
- important source of grounded theory.
- seldom provide definitive answers to research questions, but they can hint at the answers and give insights into how one could provide definitive answers.

Concerning the types of research approaches, Babbie (1995) also here writes about a blend: "Scientific inquiry in practice typically involves an alternation

between deduction and induction." Similarly, Babbie claimed that research conducted in practice involves an alteration between quantitative and qualitative observations. These blends or alterations are also the case for this dissertation research. However, in trying to classify the research approach used for this dissertation, on a whole an inductive approach best describes it. For a more precise description about the research approach, the following gives a closer look at the specific problems this dissertation were to study.

Problem number 1 has the characteristics of a deductive study. The selection the author of this dissertation makes of the best available set of project management processes from literature, can be viewed as a hypothesis that these project management processes generally are perceived quite well. The research will then reason this hypothesis to be correct or not. A survey will be conducted to get the necessary data, that for the most will be quantitative, but were participants may give qualitative comments as well.

Problem number 2 has an inductive approach. It has no hypothesis, but rather an wish to identify project management areas in need of improvement. In order to indicate areas of project management that needs improvement, the decided on set of project management processes will be presented in a mail survey to experienced project personnel. The gathered data, for the most quantitative assessments of importance and performance of each process, will hopefully give indication to where improvement efforts of project management can be concentrated. Thus, the research will reason from the specific and the known to the general and the unknown, and for the most follow the inductive approach.

Problem number 3 has also for the most an inductive approach. It has no hypothesis, but a wish to identify or develop metrics for the project management processes. After studying a rather inadequate literature on metrics, it was decided on conducting interviews with experienced project management personnel, in order to obtain a broader view on important criteria and metrics for each project management process. The interview gathered for the most qualitative information. Based on the existing literature and the interviews, a structure for how to develop metrics was decided upon, and the actual metrics for the project management processes were developed in a creative session. However, the research to problem 3 do also have a deductive part when a test on the metrics work was performed through a mail survey.

Problem number 4 may be viewed as both deductive and inductive. The hypothesis is that existing benchmarking process models are not fit for benchmarking of project management processes. After reasoning that this hypothesis is true, i.e. deductive study, it was decided to develop a benchmarking process model that would fit for benchmarking of project management, i.e. inductive study. The new model was thereafter tested or

compared, using developed evaluation criteria and my objective assessment. Thus, again a deductive part.

The presentation of the addressed research problems have for convenience been divided into -3- three parts after the worked on topics. Part 1, called *Project Management Processes*, contains both research problem 1 and 2, since the work on these problems were so close. Part 2, called *Metrics*, contains problem number 3. Part 3, called *Benchmarking Process Models*, contains research problem number 4.

Descriptions of the research steps are given in each of the three research parts.

PART 1: PROJECT MANAGEMENT PROCESSES

4. DECIDING ON SET OF PROJECT MANAGEMENT PROCESSES

This chapter will discuss project management processes and present two encountered publication that each define a set of project management processes. A discussion of these two sets will result in the selection of one for the use of this dissertation research.

4.1 UNCERTAINTY ABOUT PROJECT MANAGEMENT PROCESSES

The previous assumption that benchmarking of project management should concentrate on project management processes in order to have the right focus, had an underlying assumption that there exist a set of project management processes that are well defined and accepted by project managers in general and that there are not questions or uncertainty about them. This is not true. Several points and questions about the uncertainty regarding project management processes includes:

- Project Management have traditionally not had a focus on processes, and there are only a few publications that focus on processes, all in English. No publications in Norwegian have been encountered with sets of defined project management processes.
- Even if one where to define a quite accepted standard of project management processes, different projects and organizations will still have different use of them and maybe even a need for their own unique project management processes. The standards focus would therefore be for reference and guidance at an overview level, where the projects or organizations in question needs to select and define their own project management processes for practical use.
- Do all project management processes have the same weight or impact towards the project results? One can not really tell, but it is probably not so. The PM processes will probably have different importance. Nobody have explored this difference in importance.
- Do the different project management processes have different performance in practice today? Probably so. Even if the processes had equal importance, the contributions towards the project result would be different due to different performance.
- What are the key or evaluation criteria of each project management process? This is important in order to define measures/metrics.

Even if there would be disagreement between project management personnel, the starting point to reduce the uncertainty about project management processes would be to have a developed set of processes that are quite well accepted by project managers.

4.2 RESEARCH STEPS

The stepwise procedure followed for dissertation part 1 on project management processes are outlined below:

I. Since no literature was encountered on project management processes at the start of this dissertation, the initial work of this dissertation was to try to define and describe a set of project management processes. However, before this work had gotten far, two publications that included a set of defined project management processes were published in early 1996. The first encountered was: ISO 10006 Quality Management - Guidelines to quality in project management (ISO 10006, 1996). The second: A Guide to The Project Management Body of Knowledge by Project Management Institute (PMI, 1996). By the appearance of these two publications, it was decided to study them and select one of their set of project management processes for further work.

II. After the set of project management processes was selected, participants for Survey part 1 was identified and a questionnaire prepared and mailed to obtain project management personnel's' perceptions of the processes.

III. In the same questionnaire, the participants were asked about the performance and importance of each project management process towards the project result. Due to the many different types of projects, the focus was on construction projects to reduce the dispersion of the data.

IV. Completed questionnaires were returned, and the answers were analyzed. Conclusions were made on the perceptions of how well the project management processes were (Research problem 1 addressed).

V. Indications were given to importance and performance for each project management process, and what project management process that should be in focus for improvement and benchmarking work (Research problem 2 addressed).

4.3 PROJECT MANAGEMENT PROCESSES IN LITERATURE

The project environment have not had the same traditional focus on processes as the production (manufacturing) environment. No encountered literature on project management, published before 1996, have broken down project management into its

different processes and described their relationship. However, the view of project management as several interrelated processes must have increased, since 2 publications in 1996 have presented this view. Although these publications have a quite traditional view on project management, the process view is new. The publications are ISO 10006 Quality Management- Guidelines to quality in project management (IS0 10006, 1996) and Project Management Body of Knowledge, abbreviated to pmbok (Project Management Institute, 1996). Before the project management processes from these publications are presented, the definitions of fundamental terminology will be discussed.

Definitions of process and project management processes

What is a process? According to pmbok (PMI, 1996), a process is:
" a series of actions bringing about a result".

This is a very vague definition, and a better description is striven for.

According to ISO 10006 (1996), a process is:
" a set of inter-related resources and activities which transform inputs into outputs."

This is a very mechanical view of the process, and certainly does not describe thoroughly what a process is. Andersen (1997) focuses in his description of a process that every single process has either an internal or external customer, and this is an important point that should be brought into the definition.

Benchmarking in the production environment focus on business processes. A book on benchmarking by Andersen and Pettersen (1995) defines a business process as:

- A chain of logically connected, repetitive activities; that
- makes use of the organization's resources; to
- refine an object(physical or mental); with
- the objective of producing specified and measurable results/products; for
- internal or external customers

This five point definition was quite clear, but is maybe to detailed. In order to have a definition that can be used for the purpose of this research, an own definition was created. Based on the above definitions, the following definition has been developed and will be used in the dissertation:

> ***Process: An activity or a logical sequence of related activities that takes an input, adds value to it, and provides an output for an internal or external customer.***

What are project management processes? The ISO standard (IS0 10006, 1996) is focused on processes: "To facilitate the discussion of the guidance to quality in project management, a process approach has been adopted in this document and the project processes have been grouped into two categories: the project management processes

and the project product related processes (those who are concerned with the project product such as design, production and verification)." However, the ISO publication does not further define neither *project management processes* nor *project product related processes*. The author of this dissertation has the opinion that a publication with a set of project management processes should define the term in clear text.

The other encountered publication that focuses on project management processes by PMI (1996), defines both *project management processes and product-oriented processes*. These definitions that will be used by this dissertation, were brought up in Chapter 2 and follows:

> ***Project management processes are concerned with describing and organizing the work of the project.***
>
> ***Product-oriented processes are concerned with specifying and creating the project product.***

ISO 10006

ISO 10006 has defined a set of project management processes considered to be applicable for the majority of projects. Table 4.1a and 4.1b lists and defines these processes. It is stated that not all the processes in the table are necessarily existing in a particular project, whereas in others additional processes may be necessary.

PROCESS	DESCRIPTION
STRATEGIC PROCESS	
Strategic process	Setting the direction for the project and managing realization of the other processes
INTERDEPENDENCY MANAGEMENT PROCESSES	
Project initiation and project plan development	Evaluating stakeholder requirements, preparing a project plan and initiating other processes
Interaction management	Managing the interactions that occur during the project
Change and configuration management	Anticipating change and managing it across all process
Closure	Closing processes and obtaining feedback
SCOPE RELATED PROCESSES	
Concept development	Defining the broad outlines of what the project product will do
Scope development and control	Documenting the characteristics of the project product in measurable terms and controlling them
Activity definition	Identifying and documenting activities and steps required to achieve the project objectives
Activity control	Controlling the actual work carried out in the project
TIME RELATED PROCESSES	
Activity dependency planning	Identifying interrelationships and the logical interactions and dependencies among project activities
Duration estimation	Estimating the duration of each activity in connection with the specific conditions and with the resources required
Schedule development	Interrelating the project time objectives, activity dependencies and their durations as the framework for developing general and detailed schedules
Schedule control	Controlling the realization of the project activities, for confirming the proposed schedule or for taking adequate actions for recovering from delays
COST RELATED PROCESSES	
Cost estimation	Developing cost estimates for the project
Budgeting	Using results from cost estimation to produce the project budget
Cost Control	Controlling costs and deviations from the project budget
RESOURCE RELATED PROCESSES	
Resource planning	Identifying, estimating, scheduling and allocating all relevant resources
Resource Control	Comparing actual usage against resource plans and taking action, if needed

Table 4.1a Description of project management processes (ISO 10006, 1996)

PROCESS	**DESCRIPTION**
PERSONNEL RELATED PROCESSES	
Organizational structure definition	Defining a project organizational structure tailored to suit the project needs including identifying roles in the project and defining authority and responsibility
Staff allocation process	Selecting and assigning personnel with appropriate competence to suit the project needs
Team development	Developing individual and team skills and ability to enhance project performance
COMMUNICATION RELATED OPERATIONAL PROCESSES	
Communications planning	Planning the information and communication systems of the project
Information management	Making necessary information available to project organization members and other stakeholders
Communication control	Controlling communication in accordance with the planned communication system
RISK RELATED PROCESSES	
Risk identification	Determing risks in the project
Risk estimation	Evaluating the probability of risk occurrence and the impact of risk on the project
Risk response development	Developing plans for responding to risks
Risk control	Implementing and updating the risk plans
PURCHASING RELATED PROCESSES	
Purchasing planning and control	Identifying and controlling what is to be purchased and when
Requirements documentation	Compiling commercial conditions and technical requirements
Subcontractor evaluation	Evaluating and determining which subcontractors should be invited to supply products
Subcontracting	Issuing invitations to tender, tender evaluation, negotiation. preparation and placing of the subcontract
Contract control	Ensuring that subcontractors performance meets contractual requirements

Table 4.1b Description of project management processes (ISO 10006, 1996)

As can be seen form the table, the thirty-three -33- processes defined by ISO, are grouped into ten -10- project management process groups. The groups seems to be organized or categorized by the project management topic or knowledge area, and helps in giving an overview of the many single project management processes. The list of processes and their independent descriptions seems to be quite complete. However, there are no description or illustrations of the dependencies or inter-relationship between the processes or the process groups. This lack of description on how the different processes are inter-related, and the absolute absence of illustrations and figures, makes this document incomplete and inadequate to give a good guidance for practical use of project management processes.

The pmbok

The Project Management Institute (1996) have in Project Management Body of Knowledge (pmbok) similarly identified 5 project management process groups and in all 37 project management processes. One major difference from the ISO 10006 is that pmbok illustrates the relationship between the Process Groups (see Figure 4.1), and break these groups up in illustrations of the project management processes that are in each process group (see Figures 4.2 to 4.6).

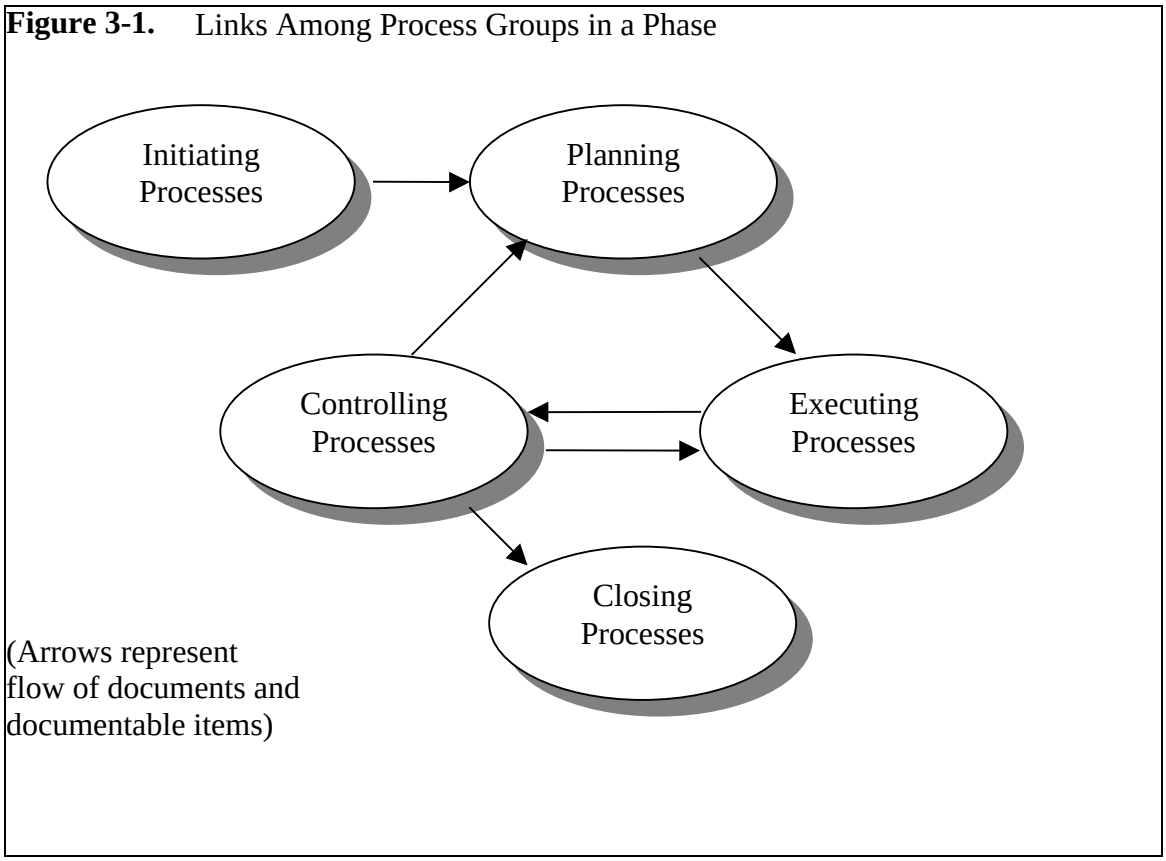


Figure 4.1 Links among Process Groups in a Phase (PMI, 1996).

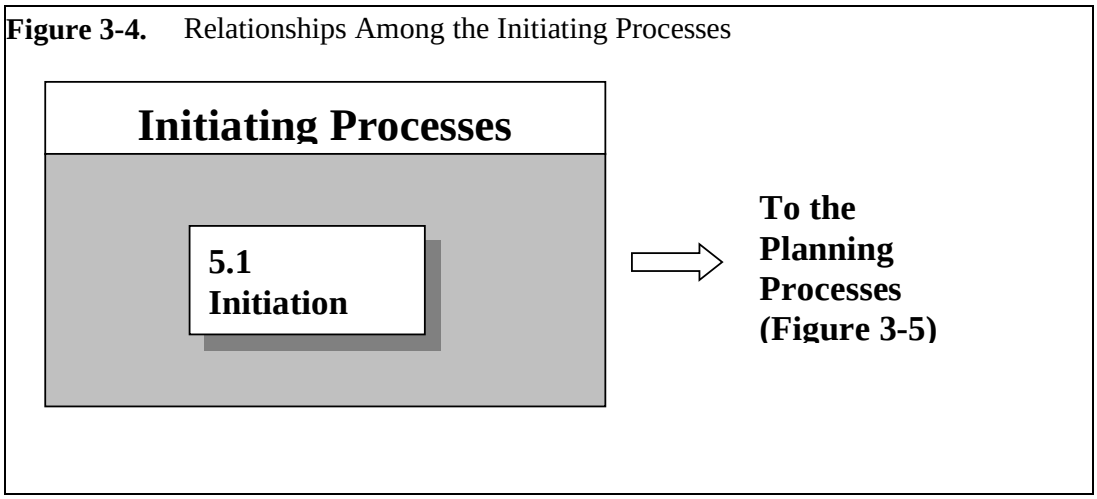


Figure 4.2 Relationships Among the Initiating Processes (PMI, 1996).

Figure 3-5. Relationships Among the Planning Processes

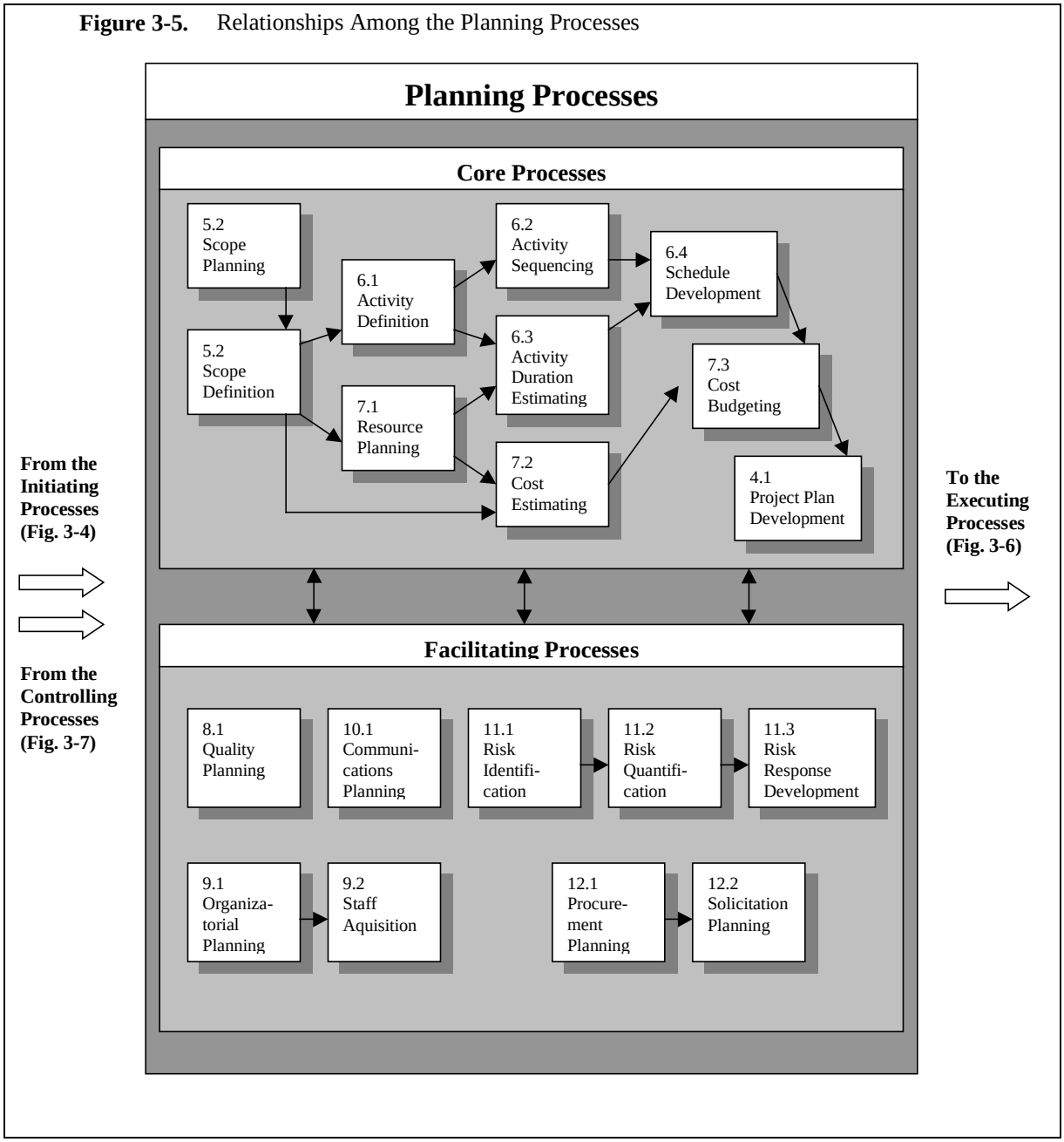


Figure 4.3 Relationships Among the Planning Processes (PMI, 1996).

Figure 3-6. Relationships Among the Executing Processes

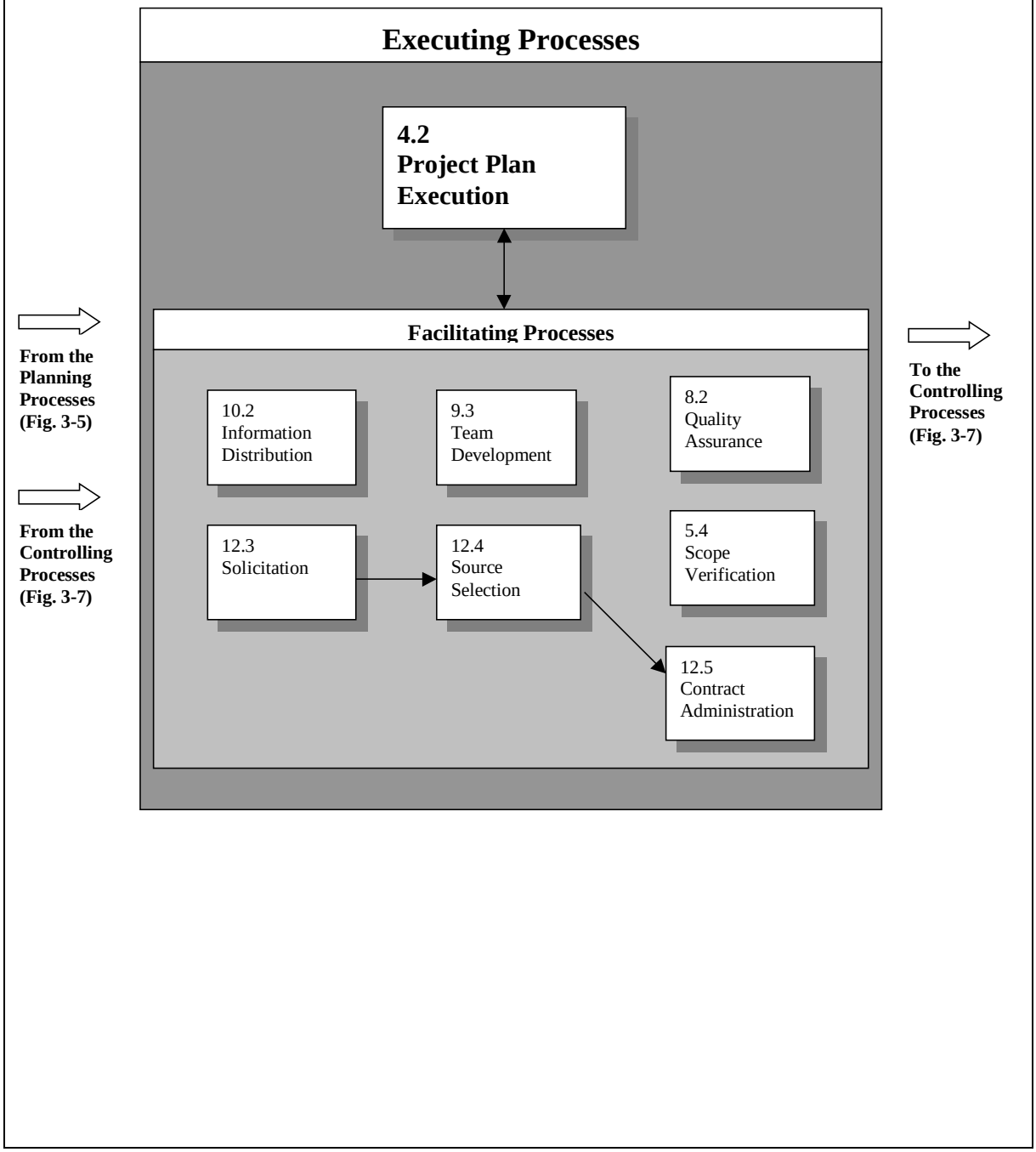


Figure 4.4 Relationships Among the Executing Processes (PMI, 1996).

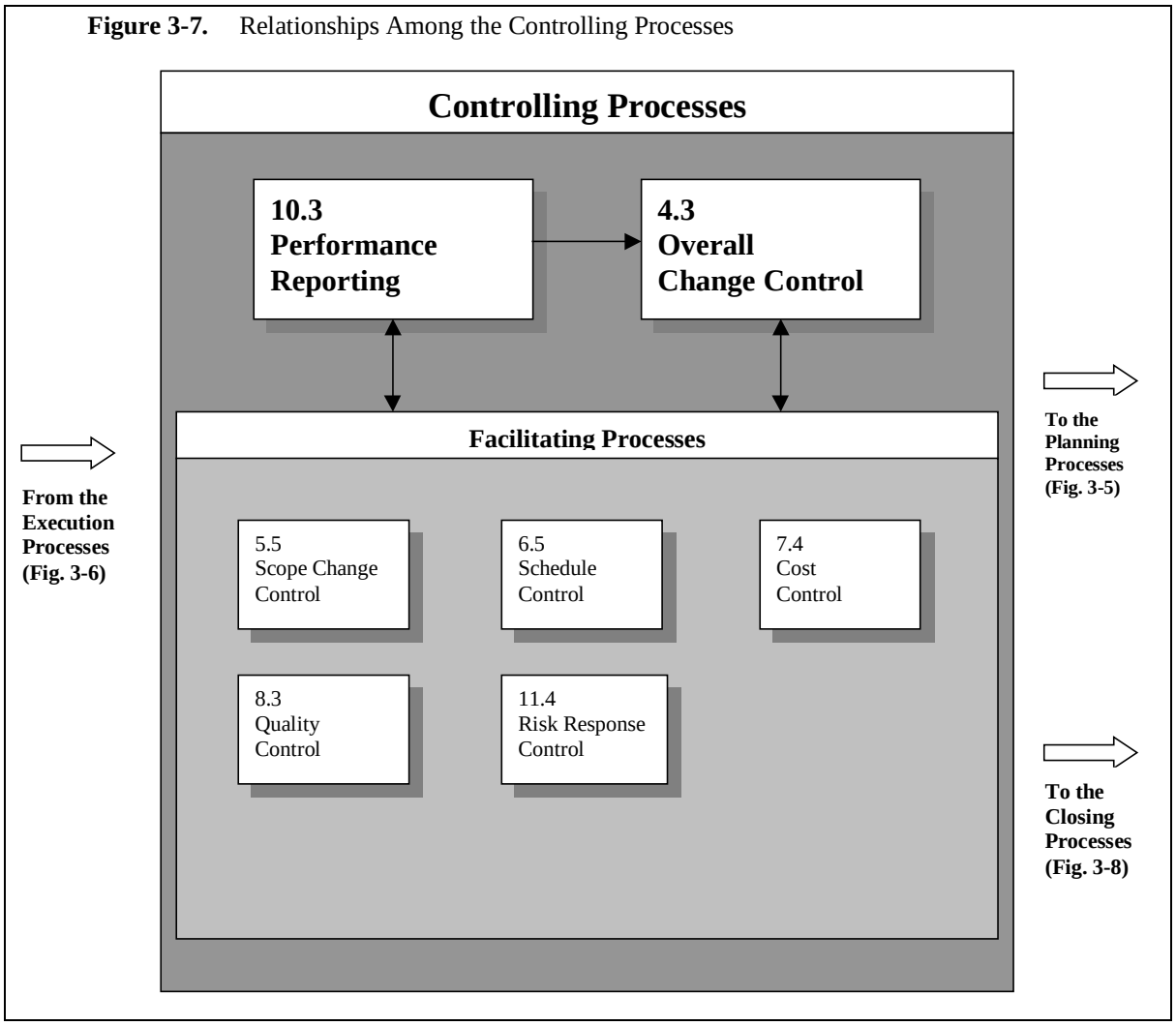


Figure 4.5 Relationships Among the Controlling Processes (PMI, 1996).

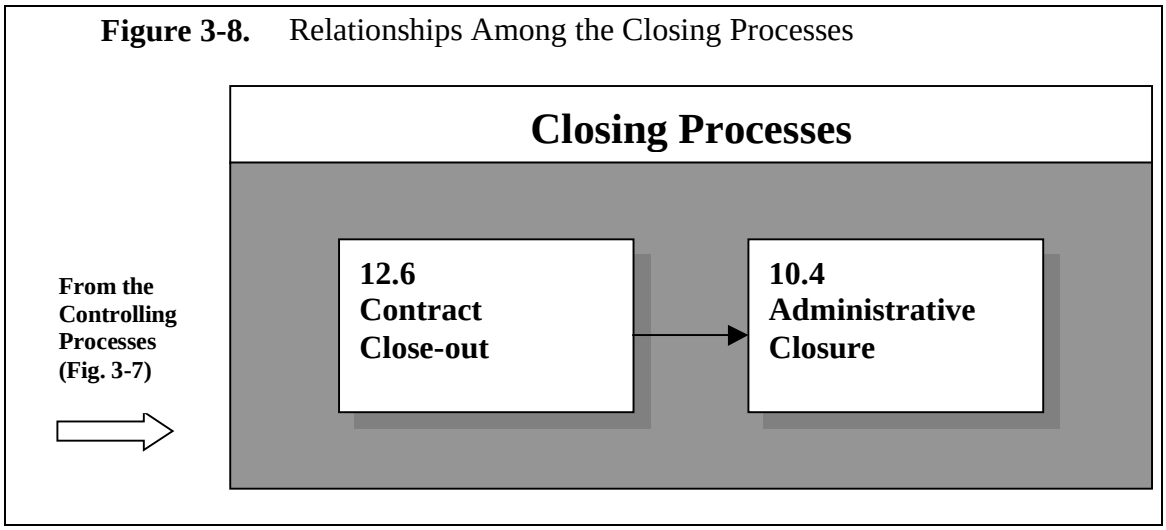


Figure 4.6 Relationships Among the Closing Processes (PMI, 1996).

As shown in the figures, the processes are divided into core processes and facilitating processes and are shown in what may be a close to time-wise appearance in an actual project. Overall, the figures illustrates well the relationship between the project

management process groups and the project management processes. The processes are also grouped into 12 project management knowledge areas (see Figure 4.7).

Figure 1-1. Overview of Project Management Knowledge Areas and Project Management Processes

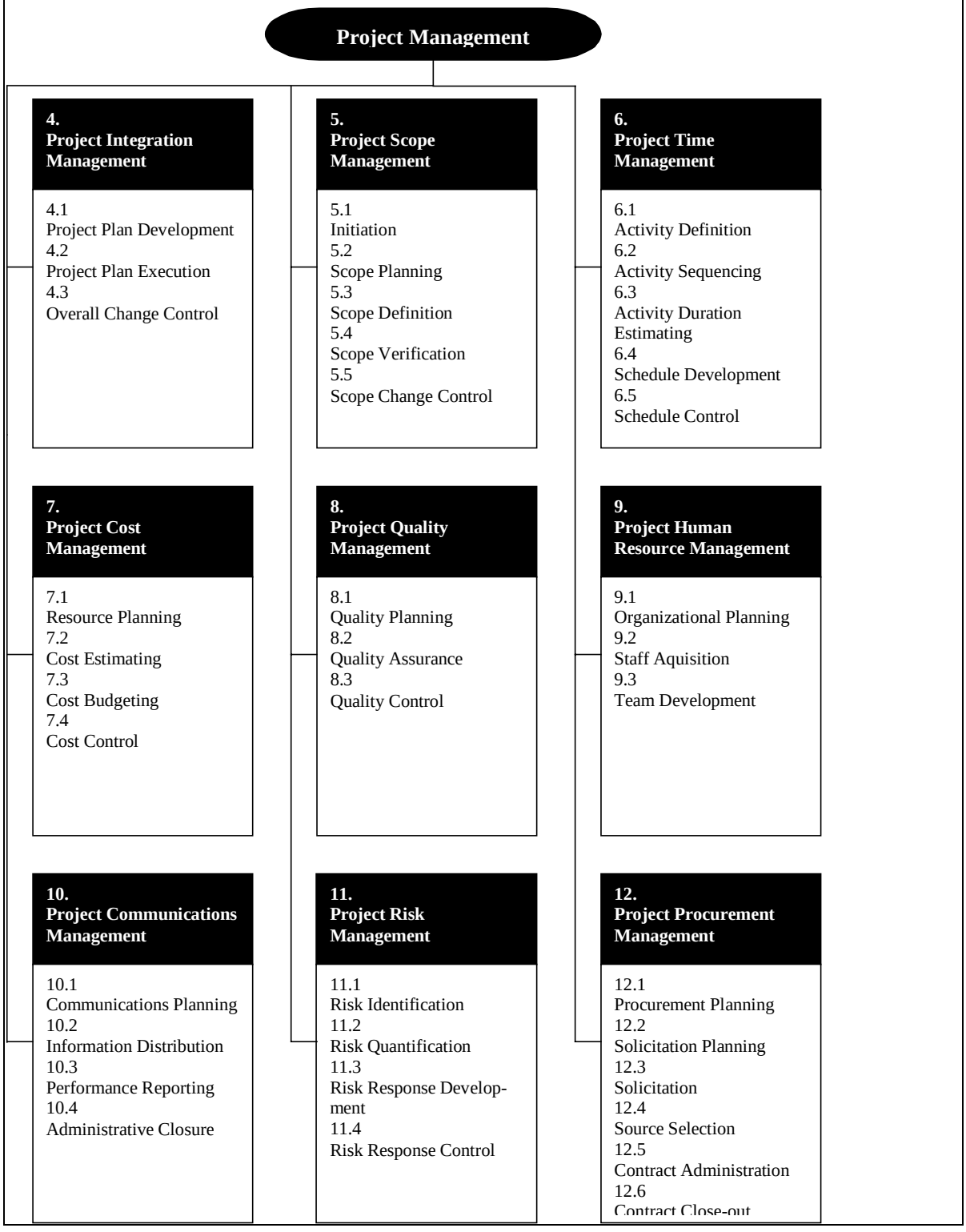


Figure 4.7 Overview of Project Management Knowledge Areas and Project Management Processes (PMI, 1996).

It is the author's opinion, that the above figure is a good illustration of the knowledge areas that project management consist of, although there might always be a discussion on the grouping and categories that are appropriate.

The definitions of the project management process groups and the project management processes are shown in Table 4.2 (a and b). Definitions of the project management knowledge areas are given in Table 4.3.

Initiating Processes- recognizing that a project or phase should begin and committing to do so.

- Initiation—committing the organization to begin the next phase of the project.

Planning Processes- devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address.

Core Processes:

- Scope planning—developing a written scope statement as the basis for future project decisions.
- Scope definition—subdividing the major project deliverables into smaller, more manageable components.
- Activity definition—identifying the specific activities that must be performed to produce the various project deliverables.
- Activity sequencing—identifying and documenting interactivity dependencies.
- Activity duration estimating—estimating the number of work periods which will be needed to complete individual activities.
- Schedule development—analyzing activity sequences, activity durations, and resource requirements to create the project schedule.
- Resource planning—determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.
- Cost estimating—developing an approximation (estimate) of the costs of the resources needed to complete project activities.
- Cost budgeting—allocating the overall cost estimate to individual work items.
- Project plan development—taking the results of other planning processes and putting them into a consistent, coherent document.

Facilitating Processes:

- Quality planning—identifying which quality standards are relevant to the project and determining how to satisfy them.
- Communications planning—determining the information and communications needs of the stakeholders: who needs what information, when will they need it, and how will it be given to them.
- Organizational planning—identifying, documenting, and assigning project roles, responsibilities, and reporting relationships.
- Staff acquisition—getting the human resources needed assigned to and working on the project.
- Risk identification—determining which risks are likely to affect the project and documenting the characteristics of each.
- Risk quantification—evaluating risks and risk interactions to assess the range of possible project outcomes.
- Risk response development—defining enhancement steps for opportunities and responses to threats.
- Procurement planning—determining what to procure and when.
- Solicitation planning—documenting product requirements and identifying potential sources.

Table 4.2a Project Management Processes by Process Groups (PMI, 1996).

Executing processes- coordinating people and other resources to carry out the plan.
Core process:
- Project plan execution—carrying out the project plan by performing the activities included therein.

Facilitating Processes:
- Information distribution—making needed information available to project stakeholders in a timely manner.
- Team development—developing individual and group skills to enhance project performance.
- Quality assurance—evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.
- Scope verification—formalizing acceptance of the project scope.
- Solicitation—obtaining quotations, bids, offers, or proposals as appropriate.
- Source selection—choosing from among potential sellers.
- Contract administration—managing the relationship with the seller.

Controlling processes- ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.
Core Processes:
- Performance reporting—collecting and disseminating performance information. This includes status reporting, progress measurement, and forecasting.
- Overall change control—coordinating changes across the entire project.

Facilitating Processes:
- Scope change control—controlling changes to project scope.
- Schedule control—controlling changes to the project schedule.
- Cost control—controlling changes to the project budget.
- Quality control—monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.
- Risk response control—responding to changes in risk over the course of the project.

Closing processes- formalizing acceptance of the project or phase and bringing it to an orderly end.
- Administrative closure—generating, gathering, and disseminating information to formalize phase or project completion.
- Contract close-out—completion and settlement of the contract, including resolution of any open items.

Table 4.2b Project Management Processes by Process Groups (PMI, 1996).

- Project Integration Management: A subset of project management that includes the processes required to ensure that the various elements of the project are properly coordinated.
- Project Scope Management: A subset of project management that includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully.
- Project Time Management: A subset of project management that includes the processes required to ensure timely completion of the project.
- Project Cost Management: A subset of project management that includes the processes required to ensure that the project is completed within the approved budget.
- Project Quality Management: A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken.
- Project Human Resource Management: A subset of project management that includes the processes required to make the most effective use of the people involved with the project.
- Project Communications Management: A subset of project management that includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.
- Project Risk Management: A subset of project management that includes the processes concerned with identifying, analyzing, and responding to project risk.
- Project Procurement Management: A subset of project management that includes the processes required to acquire goods and services from outside the performing organization.

Table 4.3 Definitions of Project Management Knowledge Areas (PMI, 1996).

The ISO and the PMI publications on project management processes are both in the right direction for a process focus on project management. To the knowledge of the author of this dissertation, their work have not been in the context of a benchmarking of project management, but their timing is excellent while the full adaption of benchmarking to project management may seem dependent on a process focus. Both publications have detailed definitions of their defined project management processes and process groups, which should be necessary for all readers to understand them in a same or similar way. If one of these publications could become a standard of project management and its processes, it would be to invaluable help for the teaching and understanding of project management. Such a standard could be a reference and give guidance on an overview level, and would benefit all parties involved in a project, e.g. with reduced mis-communications. As mentioned earlier however, the individual projects or organizations need to create their own project management processes for practical use, due to variations in projects and project management.

The selection of one of the two sets of project management processes for further use in the dissertation work, was purely a subjective choice by the author. The reader should have this in mind when viewing the following argumentation for one of the two sets.

This dissertation research will use the PMI defined project management processes. The reason for choosing the processes in PMI's pmbok, rather than the ISO processes are summarized below:

- **Definitions**: pmbok defined what project management processes and product oriented processes are. The ISO 10006 did not have clear definitions of this terminology, even if the publication list 33 project management processes.
- **Inter-relationship**: pmbok has described and made figures of the inter-relationship between the project management processes. ISO 10006 has no descriptions or illustrations about this inter-relationship.
- **Easier to understand**: pmbok has good figures that illustrates the project management processes and the categorize them into process groups. The process groups and illustrations makes the PMI processes easier to understand than the ISO processes, that are not supported with figures.
- **Potential for standard**: The pmbok has the potential of becoming a project management standard. It is in total a 176 page book that quite detailed describes project management and it's processes. In its existing version, ISO 10006 is a 24 page document with text only, that can not convey the subject project management in such a way that it becomes a standard for project management.

Thus, the project management processes used for the rest of this dissertation are the ones defined and illustrated by PMI in pmbok.

5. SURVEY TO IDENTIFY PERCEPTIONS ON PROJECT MANAGEMENT PROCESSES

This chapter will present the survey that were to address the first two research questions of this dissertation. After the introductory section, the survey preparations and the response gathering will be described. The survey participants are presented next, followed by a presentation of the participants perceptions of the PMI set of project management processes. The chapter also presents the participants perceptions of importance and performance for each project management process, and concludes with respect to improvement needs. Finally, sources of errors are discussed.

5.1 INTRODUCTION

There may be objective ways to gather information about the correctness of the project management process of PMI and of which areas of project management, i.e. which processes, that are in the highest need of improvement. One way could be to study selected project management processes for one or more projects or organizations, and try to determine if the PMI processes quite well illustrate these project management processes. Furthermore, one could through observation try to identify the processes in highest need of improvement. However, in my opinion it would be hard to plan and carry out this objective research, as well as it would be hard to draw conclusions without heavily involving subjective opinions.

This dissertation study decided upon one alternative approach. The approach was to ask experienced project management personnel of their opinions to the PMI project management processes. Further, ask about each process' importance and performance in order to indicate their improvement need. To draw on their experience rather than objectively observe and compare improvement needs myself, was believed to be a better research approach. Thus, the decided on way to gather these subjective opinions was through a survey.

5.2 SURVEY PREPARATIONS AND RESPONSE GATHERING

This survey was designed to address the two first research problems described in the dissertation purpose section (section 3.1). In sum the problems were:

1. Check the opinion or hypothesis: "the project management processes developed by PMI are fairly well perceived by project management personnel."
2. Indicate what areas of project management, i.e. what processes, that have the most (and least) need of improvement. These areas in need of improvement would thus be where benchmarking efforts should be focused.

The data needed to be collected in the research was:

- Data about project personnel's perception of the project management processes defined by PMI. For the most, wanted data was quantitative. Examples of this type of data would be perceptions given by grade of e.g. missing or superfluous project management processes and data on how well these processes are perceived to illustrate the processes that project management consist of.
- Specific data about perceived importance and performance for each project management process.
- General background data about the respondents perspective, i.e. information of the participant and the reference project that might make a difference for the answers. This could be experience, organizational belonging, type of project, size of project, etc.

It was decided to do a mail survey to obtain the needed data. A draft for a mail survey questionnaire was developed with the above problems and data needs in mind. This draft was revised and shortened after discussions with professors in USA and Norway. The final draft for a questionnaire was first tested by the author of this dissertation report, by pretending to view it for the first time and just read and answer the questions. The questionnaire was also tested on 3 volunteer people knowledgeable in project management. Comments on layout, contents, language and time to fill out the questionnaire were given, and final changes made. The questionnaire had been made with an upper limit for estimated completion time in mind. Estimated time to fill out the questionnaire should not exceed 30 minutes, in order not to bother the respondents too much. The final questionnaire is shown in Appendix B.

Initially, it was planned to ask people on member lists of project management organizations for participation to the mail survey. In the discussions and feedback from the questionnaire tests mentioned above, one issue was that the survey response data may diverge too much, due to different types of projects. The perception of importance and performance of a project management processes like Cost Control for e.g. a re-organization project of a company, would probably be very different from a construction project or a pharmacy product development project. People on the member lists may be involved in all types of projects, and the dispersion would only be known after the data was collected. It was a concern that the collected set of data may disperse too much so it would be hard to gain meaningful data for each project management process.

Another issue was that the response rate may be very low when using member lists. With a low response rate, any difference between those who respond and those who don't are likely to be higher. With a low response rate like i.e. 10%, which is not unlikely, the perceptions gathered in the survey may not be a good representative of the prospective survey population or of opinions of PROJECT MANAGEMENT

personnel in general. A low response rate could thus destroy the data, even if the actual number of participants were quite high.

Therefore, a new and different strategy was decided upon. Rather than approaching a large number of project management personnel, it was decided to approach a smaller number that were hoped to have an interest and were believed to have knowledge in the topic of the survey. In addition, the approach was to limit the survey to project management personnel with experience from construction type of projects, and focus the questionnaire on construction projects. Prospective participants were also limit to personnel with a believed knowledge of improvement work, e.g. improvement through total quality management, metrics monitoring or benchmarking.

With this new approach, the hope was to get a higher response rate as well as better quality in the answers.

In sum, several advantages was believed to follow this strategy:

- Focusing on construction projects only, would probably lead to less deviations in the response data than if all types of projects were included. The survey would thus avoid some of the expected dispersion between different types of projects and give us a higher probability of finding a more uniform perception of PMI's project management processes the importance and performance of each process.
- Restricting prospective participants to also be project management personnel believed to have previous knowledge from improvement work in the production or project environment, makes it probable that they know and comprehend the subject of the survey, which gives a better certainty of quality in the answers.
- Approaching an smaller number of project management personnel, makes it possible for better contact and follow up of the prospective participants. For instance, an advance calling and a pre-screening of people not interested or qualified to participate, could be done. Further, it is easier to send reminders if they are late to respond, and to go back and ask for additional information, or clarify ambiguous or missing information.
- Being able to contact the participants more directly, makes it probable that the response rates go up, which lead to better representative opinion of the prospective survey population and of project management personnel in general.

Project management personnel that were asked to participate came from the following 8 groups:

1. CII Benchmarking and Metrics Committee Members (14 people)
2. Project 2000's contact persons to the benchmarking research of Project 2000 and IMEC.(6 people)
3. IMEC researchers involved in benchmarking (4 people).

4. Norwegian Offshore Petroleum Industry's improvement program: NORSOK: Work-group members in Cost Analysis and Measures (8 people).
5. Interview participants described later in this dissertation for input on metrics and criteria for project management process (in total 10, but due to belongings to other groups too, the count makes 6 people).
6. Individuals in Norway and North America, identified by the dr. ing. candidate (respectively 22 and 15 people)
7. Individuals identified by Project 2000's Program Coordinator, Halvard Kilde (Kilde, 1996) (24 people).
8. Individuals identified by Project 2000 Researcher and Professor at NTNU Civil Engineering Department, Kjell Austeng (Austeng, 1996)(4 people).

All prospective participants were tried contacted in person or by phone, or was given a message from a contacted person. Of the prospective participants where direct contact was obtained, forty eight- 48 - said they would participate and 15 said maybe. Four - 4 - said no to participate, and were deleted from the list (and are not included in the numbers given above or to follow). Some groups increased slightly underway or participants changed, when people on the list gave a copy of the questionnaire to a colleague either to fill out for them, or as additional input. In sum there where 103 known prospective participants that had the questionnaire mailed or given to them.

The questionnaire collection took longer time than anticipated, due to a combination of longer time needed for the prospective participants to reply and to slow mail. The time between the envelope was postmarked in Norway to received in USA, ranged from 6 to 31 days. Reminders were sent to prospective participants which did not respond within eight weeks after the questionnaire was sent out from NTNU. They were then asked to reply by fax.

5.3 PRESENTATION OF THE PARTICIPANTS

Forty six- 46- project management personnel participated in the survey, which means that 45 percent of all known prospective participants took part. In addition, 2 more completed questionnaires were returned, but too late to be included in the analysis. Twelve -12- prospective participants sent messages that they for different reasons could not participate, which means that the total response of the known 103 prospective participants was 60, i.e. 58,3 percent. The participants and their current organizational affiliation are listed in Appendix B. The complete set of survey data is omitted from this dissertation, in order to secure anonymity of the sources.

The survey participants came from Norway and USA. As shown in Figure 5.1, 30% were from the USA and 70% from Norway. Figure 5.2 summarizes in percent the

project experience placed into 4 groups. The participants had in average 15,4 years experience from projects, with a standard deviation of 8,9 years.

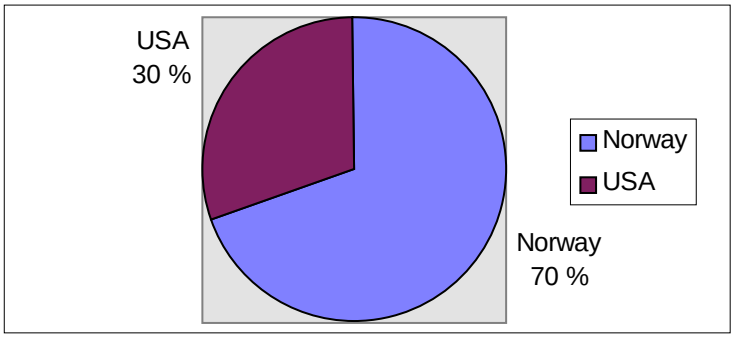


Figure 5.1. Survey participants by country.

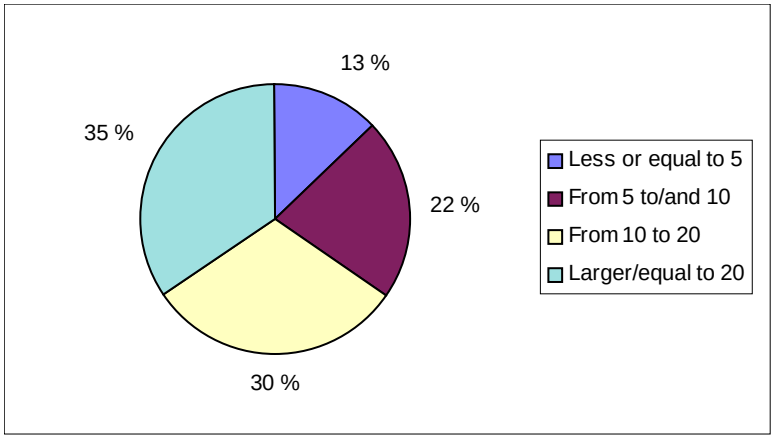


Figure 5.2: Project experience in percent, grouped by number of years worked in projects.

The survey participants were asked to select a completed construction project they have participated in, and answer the questions with this project as reference. Figure 5.3 and 5.4 shows respectively the answered types of reference projects and the participants organizational belonging during the project.

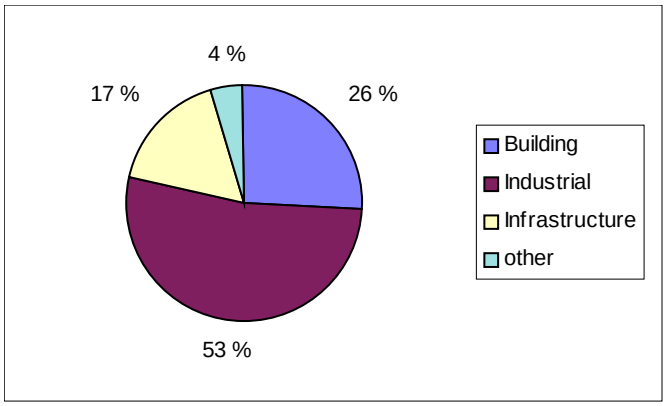


Figure 5.3: Types of reference projects.

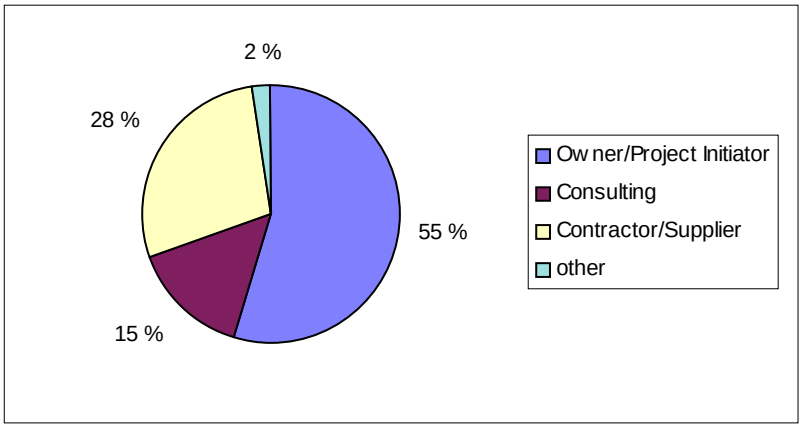


Figure 5.4: Organizational belongings of participants during the reference project.

Project Repetitiveness		**Project kind**		**Position**		**Budget (mill. NOK)**		**Duration (months)**		**Peak no. of people involved**	
←,3] yrs between projects	85%	Grass Root	76	PM	46	←,100] mill.	15	←,16]	15	←,100]	15
[4, 6] yrs between projects	7%	Moderni zation	15	PE	15	100,500	26	⟨16,30	20	⟨100,500	41
[7,→ yrs between projects	0%	Add-on	7	PA	11	[500, 2000]	26	[30,40]	35	[500, 2000]	28
o:one time	9%	other	2	other	28	⟨2000,→	33	⟨40,→	30	⟨2000,→	15

Table 5.1. Information about reference projects and participants role in the project, in percent by category.

Table 5.1 shows in percent other answered information about the reference projects. The table shows for instance that in the column “project repetitiveness”, 85% of the survey participants viewed their reference projects to be repeated by own organization in a time less than 3 years. The column “Position” shows similarly that 46% of the participants were project managers (PM) in their reference projects, while 15% where project engineers (PE), 11% project advisor (PA), and 28% had other positions.

Some of the categories that were to give information about reference projects and the participants role in the project, had selections that had much higher response rate than others. If within one category, one of the selections were very low represented and one of the others were relatively high, this created a problem for the cross analysis. For instance, if all “project kinds” were grass root projects, i.e. the kinds of reference projects were 100% grass root projects, a cross analysis would of course be meaningless when there where no other kinds of projects to compare with.

A 100% in one selection was never the case for any of the categories. However, some of the category selections had very low representation. It was necessary to decide on a minimum representation rate for being able to do cross analysis to detect differences in participants answers, due to their different reference projects or background.

A minimum response rate of 10%, which with our survey population is about 5 people, was decided to be the minimum for being able to do a cross analysis on survey participants response selections. Lower than 10% would mean that only a few participants picked the choice, and their choice could be bias or not representative. Category selections that had higher numbers than 10%, were thus okay for doing a cross analysis. Category selection with lower than 10%, resulted in that these selections were taken out of the cross analysis. If only one category selection had higher response rate than this minimum, would mean that there were none to compare with, and the whole category needed to be taken out. Note that this was the case for the category "project repetitiveness", where 85% of the respondents had reference projects that would be repeated in less than 3 years. Consequently, the category could not be compared to the 7 percent "4-6 years" or the other category selections with lower percentage number than 10, and was therefore taken out of the cross analysis. Note also that off the category "project kind", only "Grass root" with 76 percent and "Modernization" with 15 percent could be compared, when the selection "Add-on" had less than 10 percent responses.

5.4 PERCEPTIONS OF THE PMI SET OF PROJECT MANAGEMENT PROCESSES

The survey participants were asked four questions about the project management (PM) processes of PMI (see survey questionnaire, Section C. General Questions, in Appendix B). The first two questions were:

Question 1. Do you feel that there are any important project management(PM) processes left out in the preceding list of project management processes defined by PMI?

Question 2. Do you feel there are any PM processes in the preceding list that are superfluous?

The participants were asked to pick their answers on a scale from one to five, where five was "Yes, indeed", one was "No, not at all", and the middle range was somewhat in between. Figure 5.5 and Figure 5.6 shows in percentage the response made to question 1 and 2, respectively.

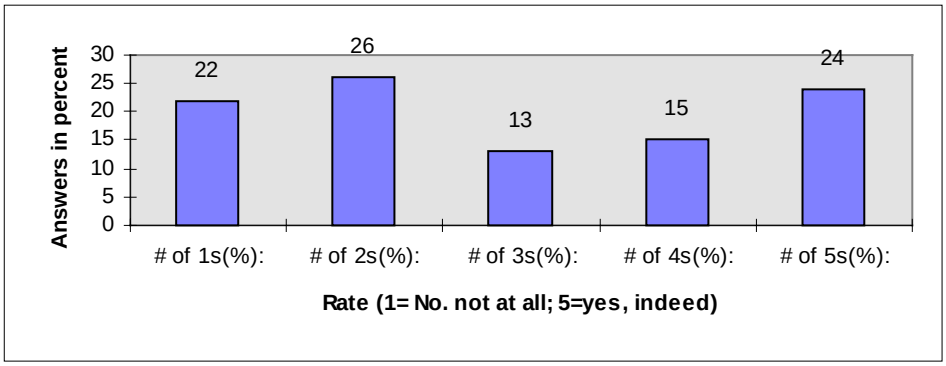


Figure 5.5: Response in percent to if there were any important PM processes left out (question 1).

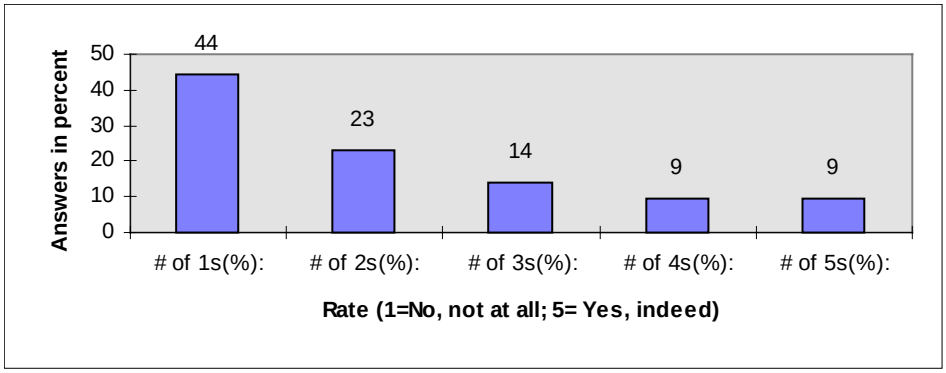


Figure 5.6: Response in percent to if there were any superfluous PM processes(question 2).

The two next questions were:
Question 3: How well can the PM processes in your reference project be illustrated by the preceding illustrated and listed PM processes?

Question 4: How well do you feel the preceding illustrated and listed Project Management Processes in general illustrates the processes you find in Project Management?

The participants were again asked to pick their answers on a scale from one to five, where five was “Very well”, one was “Very bad”. Figure 5.7 and 5.8 shows in percentage the response made to question 3 and 4, respectively. Table 5.2 gives a statistical summary of the four questions.

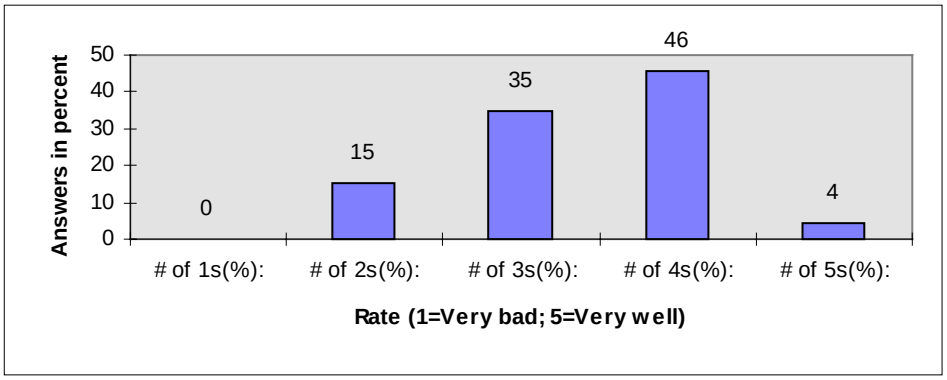


Figure 5.7: Response in percent on how well the PMI processes illustrate the PM processes in the reference projects (question 3).

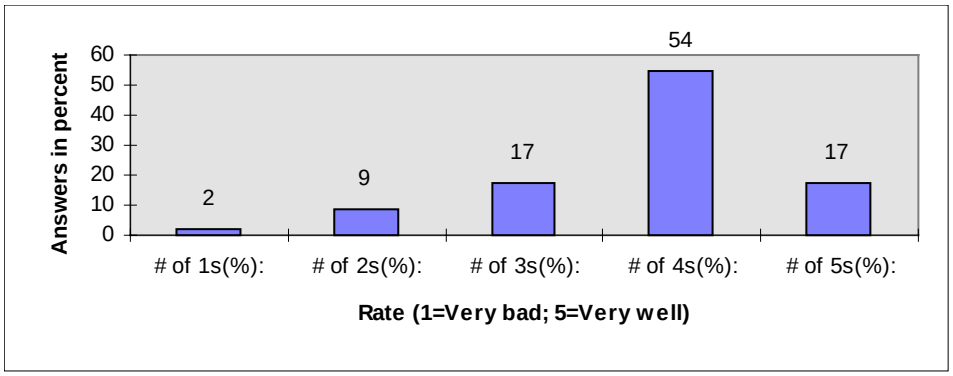


Figure 5.8: Response in percent on how well the PMI processes illustrate PM in general (question 4).

	Question 1	Question 2	Question 3	Question 4
Mode	2	1	4	4
Median	3	2	3,5	4
Average	2,9	2,2	3,4	3,8
St. Deviation	1,5	1,3	0,8	0,9

Table 5.2: Some statistical figures of the answers to the four questions.

Analysis and preliminary conclusions.

With regard to question 1, the participants had highly different opinions to whether or not there were any important PM processes left out in the PMI defined list. The answer to this question had a standard deviation of 1,5, the highest of the four. The modal answer, i.e. the most picked answer was 2, chosen by 26 percent of the participants. Forty eight - 48 - percent of the participants chose the answers 1 or 2, meaning that there were not any important PM processes left out in the PMI list. Thirty-nine - 39 percent had the total opposite answer of 4 or 5, meaning that they “Yes, indeed” felt there were important processes left out. Fifteen -15- percent picked the neutral 3. There were a majority, i.e. 48 against 39 percent, of the participants that replied that no important project management processes were left out in the processes defined by PMI.

However, this majority was so small that this research can only conclude the existence of high differences in opinion to question 1.

The finding that some participants felt that some project management processes were lacking, may be reasonable because PMI stated that they have defined processes that can be found in majority of projects but not found in all projects. PMI have thus described what they believe are the most common project management processes, and are aware that there exist more project management processes. Thus, the 37 project management processes defined by PMI may be slightly too few to describe all processes that project management consist of.

Question 2, whether it was any superfluous PM processes on the list, seemed to have a better agreement among the participants. The most picked answer (mode) was 1 with 44 percent, followed by answer 2 with 23, meaning that 67 percent of the respondents meant that there were no superfluous processes in the list. Only 9 percent chose the answer 5, and answer 4, adding this up to 18 percent that felt the list had processes that were superfluous.

The finding that the survey participants leaned towards the opinion that there were no superfluous project management processes among the 37 PMI defined ones, may also be reasonable. In view of the above comments and findings to question 1, that the 37 defined project management processes only includes the most general ones and might be too few, it would be strange if the participants found many of the processes superfluous. This research conclude that the survey population perceived all PM processes defined by PMI as important and that few were perceived superfluous. This perception holds probably true for all construction type of projects.

Regarding question 3, Figure 5.7 shows that the respondents reference projects quite well are illustrated by the project management processes defined by PMI. Forty six - 46- percent picked the answer 4, whereas 4 percent picked 5. This totals to 50 percent of respondents meaning that the project management of their reference project were well illustrated by the PMI processes. Thirty five - 35- percent picked the neutral 3, fifteen -15- picked 2, and no one picked the answer 1, “Very bad”. Note that the answer to this question had an average of 3,5 and had the lowest standard deviation: 0,8 of the 4 questions (see Table 3.2). Consequently, the conclusion was that the survey participants perceived the PMI processes to illustrate the PM processes in their reference projects quite okay.

That so many participants found the PMI set of project management processes to well illustrate the processes on the reference project, was surprising. In view of earlier comments in the previous chapter that each project or organization needs to define their own project management processes, due to differences in types of projects and project management, the expected answers to this questions were believed to become lower. Thus, this means that the participants perceive the PMI set of project management processes better than expected.

For question 4, Figure 3.8 shows that 17 percent picked the answer 5, “Very well”, and 54 percent the answer 4, totaling it to 71 percent of respondents meaning the PMI processes well illustrate project management processes in general. Only 2 percent picked the answer 1, “very bad”. The survey respondents perceived the PMI processes to illustrate the project management processes that exist in project management in general, quite well. The PMI processes were perceived better for project management in general, than for the project management of their reference project.

Since the PMI set of project management processes are the most common processes, it was not surprising that the participants would respond better to that the processes illustrate project management in general, rather than illustrate their reference project.

In sum, the answer to the four questions show that the PMI defined project management processes are well perceived by the participants, even if some processes are missing.

Cross analysis

A cross analysis of categories of the questions 1 to 4 was done, to see if there were any major differences in the answers based on the participants background or reference projects. The answers/data was viewed by the following categories and sub-categories already mentioned in the presentation of the participants:

1. by country (USA or Norway)
2. by type of project (building, infrastructure or industrial),
3. by project repetitiveness (taken out due to little dispersion of responses)
4. by kind of project (Grass Root or Modernization),
5. by organizational belonging (Owner, Consulting, or Contractor)
6. by position in the reference project (PM, PE or PA)
7. by number of years experience with projects, that is ⟨←,3], [4, 6], or [7,→ yrs between projects
8. by size of project budget, that is ⟨←,100], ⟨100,500 , [500, 2000], or ⟨2000,→ million NOK.
9. by duration of project, that is ⟨←,16], ⟨16,30 , [30,40], or ⟨40,→ months.
10. by peak number of people involved, that is ⟨←,100], ⟨100,500 , [500, 2000], or ⟨2000,→ people.

Many other categories could have been selected to group participants background and reference project, but the 10 listed above was the most obvious choices and were believed to show deviations in opinions by sub-categories, if any. As mentioned earlier, the third category on the list, project repetitiveness, was taken out due to that nearly all participants selected one sub-category and thus equal this category to the

total survey population. Some of the initial sub-categories were also taken out due to low selection from the survey participants. All sub-categories listed above were used.

There were small differences between the answers for the total survey population and the answers based on each category. Only significant differences were decided to be reported. Based on a close look at the differences in the averages to the four questions, it was decided to report differences were the answers to two of the four questions had higher average difference than 0,5 for the sub-categories.

Of the 9 used categories, there were only two categories, *Country* and *Organizational belongings*, that were studied further. These categories are shown in the Figures 5.9 and 5.10 below. The other categories had about the same relationship as the total, i.e. they were close to a replication of the results in the total response.

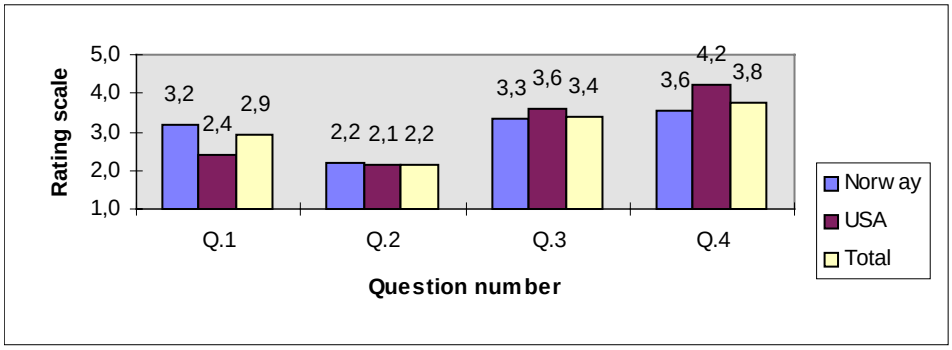


Figure 5.9: Answers to questions 1 to 4, grouped by country and total.

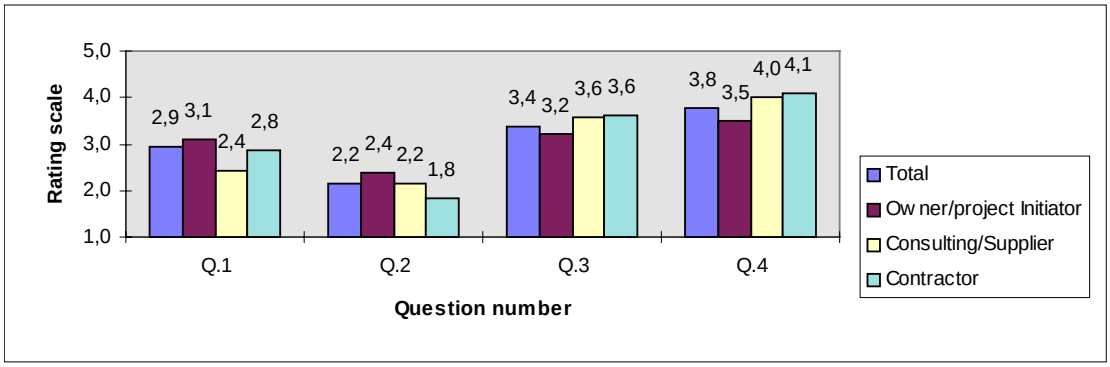


Figure 5.10: Answers to question 1 to 4 grouped by organizational belonging and total.

The above figures shows that there are not very large differences in each category's average answers to the four questions.

Figure 5.9 shows that respondents from USA had a more positive perception of the project management processes defined by PMI than respondents from Norway. For question 1 asking if any important processes were left out, respondents from USA had an average of 2,4 compared to the Norwegian 3,4, where 1 was the most positive from the PMI point of view. Similar observations are made for question 3 and 4, about how well the project management processes in the reference project and in general, respectively, can be illustrated by the PMI defined processes. In these questions where

5 was the most positive answer seen from the perspective of PMI, respondents from USA and Norway answered respectively: 3,6 compared to 3,3 for question 3 and 4,2 compared to 3,6, for question 4. This research do not have any explanation for these differences. However, due to that the survey language was English and not Norwegian, one guess is that respondents from Norway may have felt more alien or unknown to the terminology and therefore felt less familiar to the PMI model.

Grouped by the survey participants' organizational belonging during the reference project, Figure 5.10 shows similarly that from the PMI perspective, respondents from contractors and consultants had a more positive answers than respondents from the owners to the four questions. That is, the owners were for some reason most negative to the PMI processes.

Conclusion

In sum, the research conclude with the following with regard to dissertation research problem 1 (if the PMI project management processes were perceived well or not):

From the respondents construction project perspectives, the answers to question 2 strongly indicates that all project management processes defined by PMI are all important and none of them are superfluous. Answers to question 1 indicates that for some projects the project management processes by PMI are quite complete, but for others there are project management processes left out. Answers to question 3 and 4 shows that the project management processes illustrated and defined by PMI are well perceived by the respondents, which probably means that the PMI processes quite well illustrate project management processes in construction type of projects.

5.5 IMPORTANCE AND PERFORMANCE PERCEPTIONS OF EACH PROJECT MANAGEMENT PROCESS

Background philosophy

The philosophy behind asking survey participants for importance and performance to project management processes is illustrated in Figure 5.11, based on Andersen(1996).

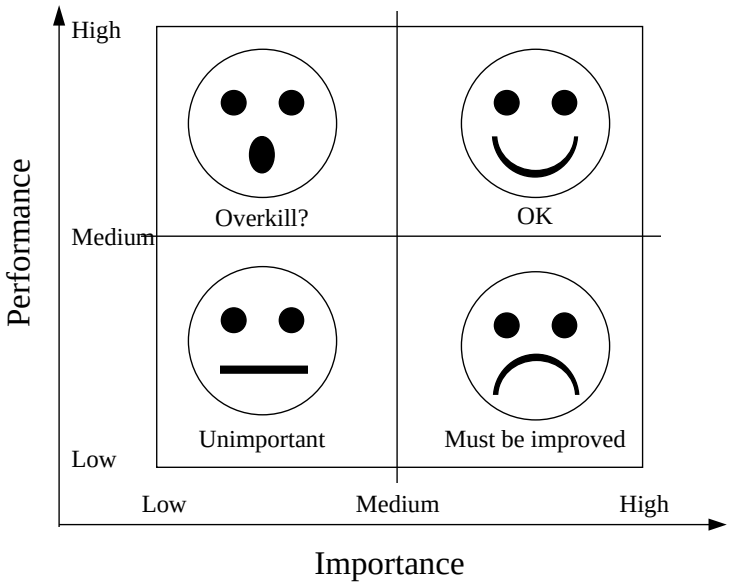


Figure 5.11 Performance Matrix, illustrating the relation between Importance versus Performance for a process (Based on Andersen, 1996).

The Performance Matrix figure above illustrate that when both importance and performance for a process is high, the situation is satisfactory and the process should not be in the focus for improvement. This quadrant is however of interest, because it is here that the "best practice" processes are found, i.e. where the processes that are performed best are found. The figure illustrate this with an OK and a smiling face.

When the importance of a process is low, it does not matter if the performance is low too, so this process should neither be in focus for improvement (Illustrated in the figure by Unimportant and a horizontal mouth).

When performance of a process is high and the importance is low, there might be too much efforts concentrated on this process or an "overkill".

Finally, when the importance for a process is high, and performance is low, the situation is unsatisfactory and the process must be improved (see the sour face in the figure). It is the processes in this quadrant that this research tries to identify.

However, research in practice do often become more complicated than the philosophy above might indicate. This was the case for my research, too. As an example of this, Figure 5.12 below shows the average importance plotted against average performance for each of the 37 project management processes.

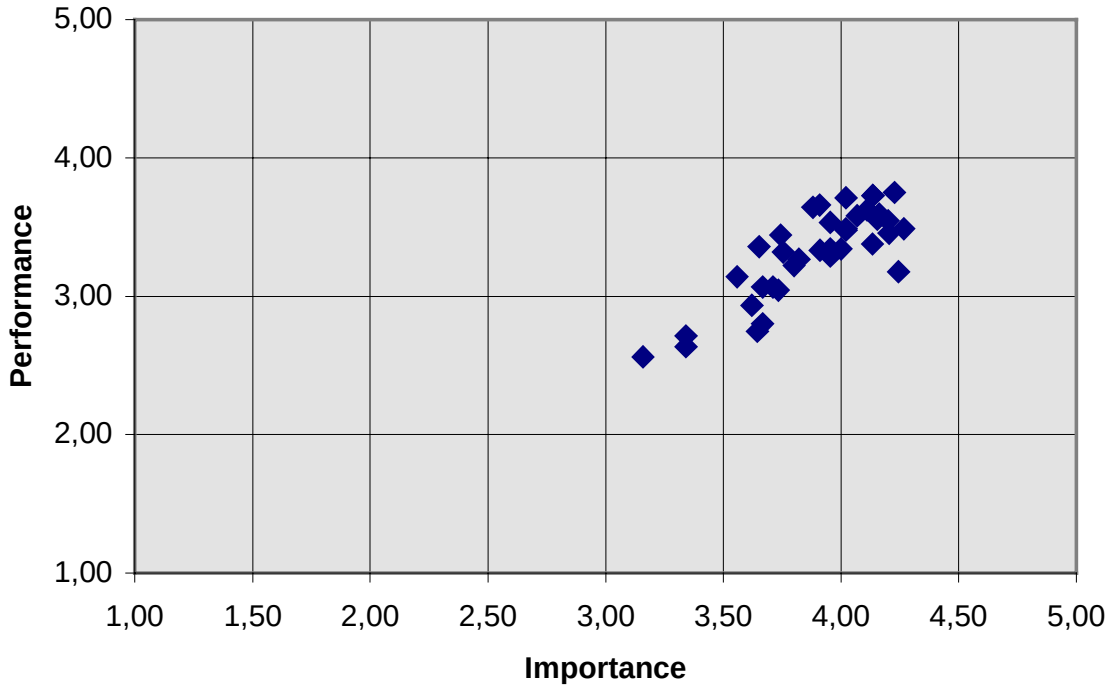


Figure 5.12 A plot of average importance against average performance for each of the 37 project management processes (5= high; 1=low)

It was not so easy to draw conclusions about improvement needs based on the performance matrix. The figure shows that the plots do not go into all 4 quadrants. The plots for all 37 processes end up in a cluster. According to the participants answer, all processes have more or less a high importance and a medium performance. The spread between them are just too little to easily point out in the matrix which process that are indicated to be in the highest need of improvement.

One way to overcome this problem could be to change the scales, so the differences between the plots became clearer. This was tried, but unfortunately not successfully, when the process plots did not really become more dispersed. An alternative way to study the data was found. The way this research tried to target the processes that has the highest need of improvement, was by focusing on the processes with the largest deviation between importance and performance, i.e. to look at survey participants given values for importance minus given values for performance. The analysis will be further explained in the following section.

Presentation of Analysis and Data

The questionnaire (Appendix B) asked the survey participants to rate their answer of importance and performance for each project management process on a scale from 1 to

5. If the process in their opinion had very high importance/performance, they were asked to pick 5. If the process had very low importance/performance, they were asked to pick 1. If somewhat in between, the participants were asked to pick a number from the middle range.

There are several ways to illustrate the respondents answer to performance and importance of each project management processes. The number of answered 1s, 2s, 3s, 4s and 5s for every process, or median, mode, average, and standard deviation, all tell us something about the answers.

However, this research is interested to capture the respondents overall indication to what project management processes that should be in focus for improvement. Average numbers of the given grades to each process are easy to comprehend and gives a clear number to the importance and performance. The average scores to both importance and performance were thus calculated.

According to the philosophy illustrated by Figure 5.11 and explained above, the average importance for a process minus the average performance should give indication to where the improvement focus should be. If the subtraction value is high, the difference between importance and performance is high, and the situation is unsatisfactory. Consequently, the processes with these high subtraction values should be prioritized for improvement.

The participants average grades on importance and performance for each project management process were therefore calculated, and the subtraction value calculated. The respondents average grades on performance and importance to each process, are shown in Figures 5.13A and 5.13 B, along with the value of average importance minus average performance.

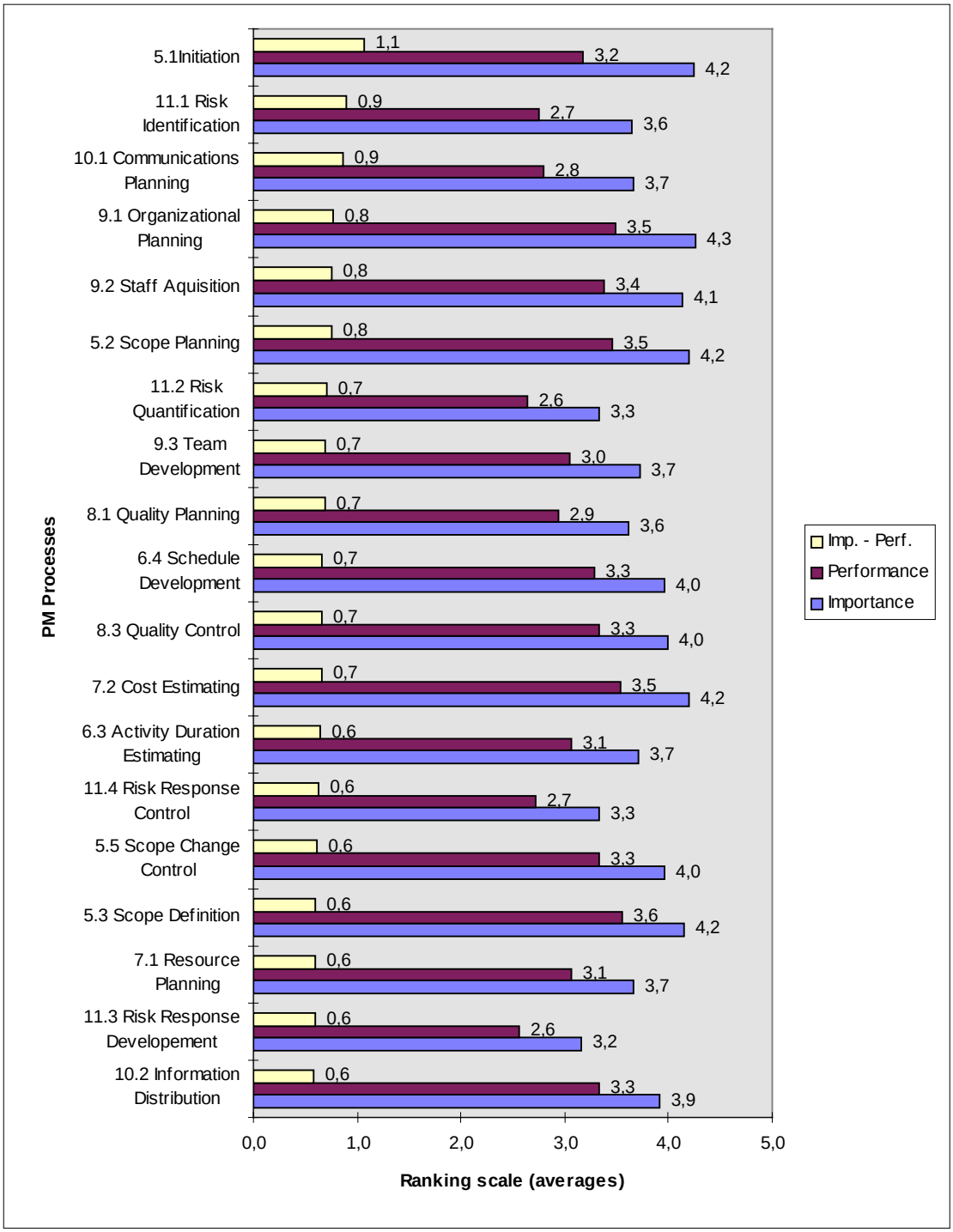


Figure 5.13A: Project management processes with averages for importance and performance, and average importance minus average performance (sorted after decreasing value of the latter).

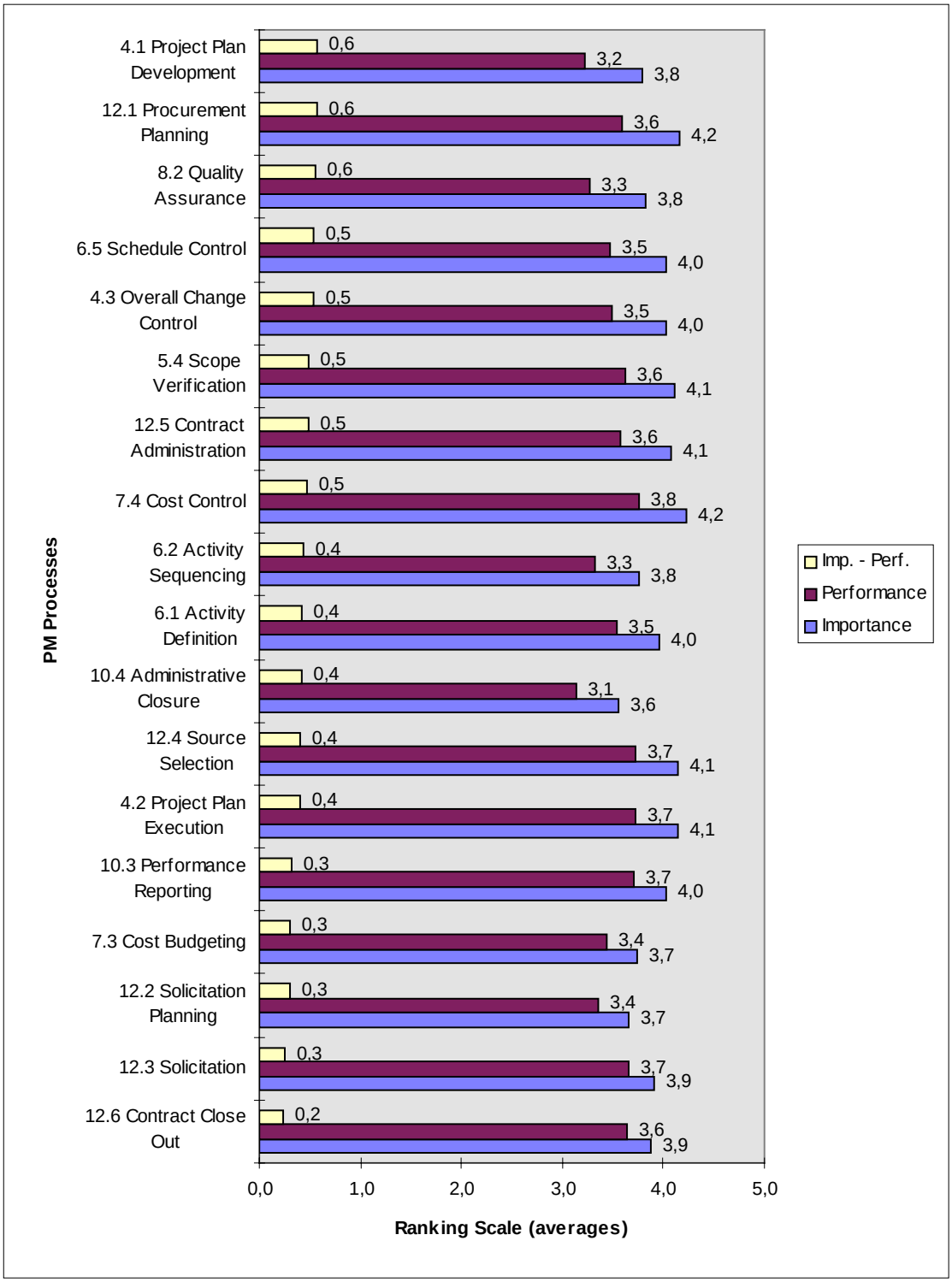


Figure 5.13B: Project management processes with averages for importance and performance, and average importance minus average performance (sorted after decreasing value of the latter).

The figures show that according to the survey participants, the project management process that were most important in the reference projects was Organizational Planning with average assigned value of 4,3, followed by six processes with 4.2 that included the processes: Initiation, Scope Planning, and Cost Estimation.

The project management process with highest performance was Cost Control with average assigned value of 3,8, followed by three processes with 3,7, i.e. Source Selection, Project Plan Execution, and Performance Reporting.

Since the processes with the highest value of average importance minus average performance are the ones that are most unsatisfactory and in the highest need of improvement, the processes in the figures above are listed in decreasing order of this subtraction value.

Findings and Preliminary Conclusions

The above average values suggest that the project management process in most need of improvement in the participants reference projects is the one on top, i.e. the Initiation Process, with a 1,1 average importance minus average performance value. The processes Risk Identification and Communications Planning follow in improvement need with a 0,9 value. Then there are several processes with the subtraction value 0,8 and 0,7, continuing down to the process in least need of improvement, Contract Close-out, with a subtraction value of 0,2. Note that there are no processes with a negative subtraction value, i.e. an average with a higher performance than importance that may have suggested an overkill.

The Figures 5.13A and 5.13B should tell us which single project management processes to focus on in improvement efforts. However, the difference in average importance and average performance between the processes listed in the figures where not high. From the project management process in most need of improvement, Initiation, to the process in least need of improvement, Contract Close-Out, the difference in the average importance minus performance value were only 0,9. With a higher difference, the conclusions on what project management process to focus on for improvement could have been stronger. Consequently, the research can not conclude that it has identified what single project management processes that should be the focus for improvement of project management in general. The research concludes that it has indications to what single project management processes that should be the focus for improvement of project management.

An interesting view of the improvement need for project management was found by moving the focus one level up and look at the project management process groups. By looking at the process groups belongings for the project management processes in most need of improvement, it was identified that they did not evenly spread out on all groups, but rather that some groups seemed to have a higher representation than others.

Of the three -3- project management processes indicated to be in most need of improvement in Figures 3.12A and B, one -1- of them belonged to the initiating group and two -2- to the planning group. Looking further down to the 6 first processes in highest need of improvement, one was from the initiating group and 5 from the planning group. This process group belongings for the top 6 processes are illustrated in Figure 5.14.

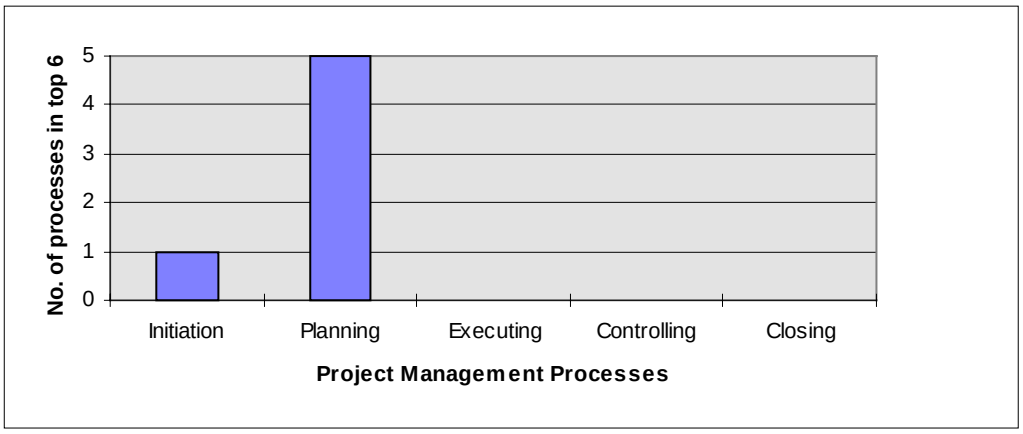


Figure 5.14 Process groups belongings for the 6 project management process groups indicated to have the highest need of improvement.

A similar pattern was found also when looking at the 12 first in highest need of improvement. Figure 5.15 illustrates the belongings to process groups for the 12 project management processes with the highest value in average importance minus average performance, i.e. highest indicated need of improvement.

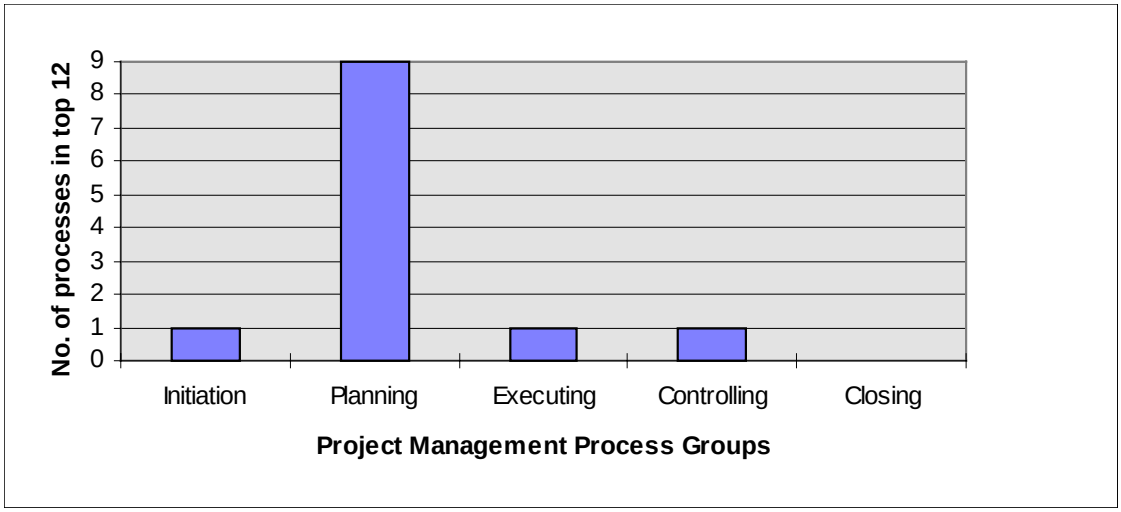


Figure 5.15 Process groups belongings for the 12 project management process groups indicated to have the highest need of improvement.

The figure shows that of the top 12 project management processes with the highest indicated need of improvement, one were initiation process and nine were planning processes. That means that of the top 12 processes in need of improvement, ten -10- were processes that usually are conducted early in the project, i.e. initiation and planning processes. Only 2 of the 12 processes in highest need of improvement, i.e. the processes Team Development and Quality Control, where not in this two process groups. It could be discussed if Team Development really belongs in this process group only, and not in all or other process groups.

However, the above finding is that the process groups initiation and planning are higher represented than other groups among the top three, top six, and top twelve processes indicated to be in most need of improvement. This is a strong indication that on the participant's reference projects, it is the project management processes performed early in the project that have the highest need of improvement, and i.e. where benchmarking should be focused.

Cross analysis

The above analysis and figures showed the relationship between all reference projects. The 12 project management processes indicated to be in most need of improvement are shown with their values for average importance, average performance, and avg. importance minus avg. performance in Table 5.3, ranked after need of improvement, i.e. avg. importance minus avg. performance.

Project Management Process	*Avg.Imp.*	*Avg.Perf.*	*Avg. Imp. - Avg. Perf.*
5.1 Initiation	4,2	3,2	1,1
11.1 Risk Identification	3,6	2,7	0,9
10.1 Communications Planning	3,7	2,8	0,9
9.1 Organizational Planning	4,3	3,5	0,8
9.2 Staff Acquisition	4,1	3,4	0,8
5.2 Scope Planning	4,2	3,5	0,8
11.2 Risk Quantification	3,3	2,6	0,7
8.1 Quality Planning	3,6	2,9	0,7
9.3 Team Development	3,7	3,0	0,7
6.4 Schedule Development	4,0	3,3	0,7
8.3 Quality Control	4,0	3,3	0,7
7.2 Cost Estimating	4,2	3,5	0,7

Table 5.3 Project Management processes ranked after Avg. Importance minus avg. performance

On the reference projects in general, these were the top 12 project management processes indicated to be where an improvement effort like benchmarking should be focused.

The survey participants had different background and reference projects. A cross analysis was undertaken to see if the background or reference project categories made any difference for the participants answers, and how this would influence the top ranked processes. The survey data was grouped into the 9 decided on categories previously described. Again, it was the value of average importance minus average performance that was calculated and studied. The difference between the sub-categories' values of average importance minus average performance would tell if the category were homogenous, i.e. in agreement, or dispersed, i.e. in disagreement, with respect to the improvement need of the process in question.

The following cross analysis discussion will focus on the 12 project management processes indicated to be in the highest need of improvement.

Project Management Process	*Norway*	*USA*	*D>0,5?*
5.1 Initiation	1,0	1,0	
11.1 Risk Identification	1,1	0,4	yes
10.1 Communications Planning	1,0	0,6	
9.1 Organizational Planning	0,8	0,8	
9.2 Staff Acquisition	0,7	0,8	
5.2 Scope Planning	0,6	1,1	
11.2 Risk Quantification	1,0	0,2	yes
8.1 Quality Planning	0,7	0,6	
9.3 Team Development	0,6	0,9	
6.4 Schedule Development	0,5	0,9	
8.3 Quality Control	0,7	0,6	
7.2 Cost Estimating	0,8	0,4	

Table 5.4 Differences in avg. importance minus avg. performance by Category 1. Country.

Table 5.4 shows the values for average importance minus average performance for the sub-categories Norway and USA. The difference between the sub-category values are not calculated, but a "yes" is marking when a project management processes have a difference between the values for these sub-categories higher than 0,5. After studying the calculated data, the value 0,5 was initially decided upon to illustrate when there were any major difference between the sub-categories.

Ten of the above processes had a difference 0,5 or lower, and only two had higher, i.e. Risk Identification and Risk Quantification. The perception of survey participants from Norway were that these two processes were in high need of improvement, with a calculated avg. importance minus performance value 1,1 and 1,0, respectively. The US participants had this value much lower, respectively 0,4 and 0,2. Thus, among the reference projects, these processes would not be in the top group for improvement in USA, but they would in Norway (and for the total survey population).

Similar analysis were done for the other categories. For Category 2, Type of Project, Table 5.5 shows the only process with a higher difference than 0,5 between each sub-categories' average importance minus average performance. For space reasons, only the processes that by category were singled out to be among the top four in highest discrepancy with total population are shown.

Project Management Process	*Building*	*Infrastructure*	*Industrial*	*D>0,5?*
9.2 Staff Acquisition	1,1	0,5	0,7	yes

Table 5.5 Discrepancy for the Type of Project category (category 2).

The Type of Project category had a quite uniform perception on the improvement need for the top 12 processes. The category were thus close to a replication to the perceptions of the total survey population combined. The discrepancy in the category was only for the staff acquisition process. In building projects, the staff acquisition

process had a higher importance minus performance perception, i.e. higher improvement need, than in infrastructure or industrial projects.

The next category, Kind of Project, were also quite in agreement with the total survey population. Two processes qualified to have a higher value than 0,5 between the sub-category calculations, and are shown in Table 5.6.

Project Management Process	*Grass Root*	*Modernization*	*D>0,5?*
9.2 Staff Acquisition	0,9	0,1	yes
5.2 Scope Planning	0,9	0,1	yes

Table 5.6. Discrepancy for the category Kind of Project

For some reason, reference projects that could be categorized as Modernization had a less need of improvement in the two processes Staff Acquisition and Scope Planning, than Grass Root projects.

The rest of the 9 categories had all many processes with higher differences between sub-categories values than 0,5. In order to single out the processes with the highest discrepancies with the total population, the limit 0,5 was to low. Thus it was increased and set to different values for each category. The tables 5.7 to 5.12 show similar discrepancies by the remaining categories.

Project Management Process	*Owner*	*Consultant*	*Contractor*	*D>1,0?*
11.1 Risk Identification	0,5	1,6	1,4	yes
11.2 Risk Quantification	0,4	1,7	0,8	yes
8.1 Quality Planning	0,3	1,6	0,8	yes
6.4 Schedule Development	0,2	1,6	0,9	yes

Table 5.7 Discrepancy for the category Organizational Belonging

Project Management Process	*PM*	*PE*	*PA*	*D>0,8?*
10.1 Communications Planning	0,8	0,9	1,6	yes

Table 5.8 Discrepancy for the category Position (Project Manager, Project Engineer, or Project Advisor)

Project Management Process	*Less eq. to 5*	*or 5 to, and 10*	*10 to, but not 20*	*20 or more*	*D>1,2?*
5.1 Initiation	2,0	0,6	0,7	1,3	yes
10.1 Communications Planning	1,8	1,1	0,5	0,7	yes
9.2 Staff Acquisition	1,8	0,6	0,3	0,8	yes

Table 5.9 Discrepancy for the category Experience (yrs)

Project Management Process	*100 or less*	*100 to, but not 500*	*500 to, and 2000*	*Larger than 2000*	*D>0,8?*
5.2 Scope Planning	0,1	1,0	0,9	0,7	yes
11.2 Risk Quantification	0,2	1,0	0,7	0,8	yes

Table 5.10 Discrepancy for the category Budget (million NOK)

Project Management Process	*16 or less*	*16 to, but not 30*	*30 to, and 40*	*Larger than 40*	*D>1,2?*
10.1 Communications Planning	0,6	1,9	0,9	0,4	yes
8.1 Quality Planning	0,0	1,3	0,7	0,6	yes

Table 5.11 Discrepancy for the category Project Duration (months)

Project Management Process	*100 less*	*or 100 to, but not 500*	*500 to, and 2000*	*More than 2000*	*D>1,0?*
10.1 Communications Planning	0,7	1,1	1,4	0,3	yes
9.1 Organizational Planning	0,7	1,1	1,2	0,2	yes
9.2 Staff Acquisition	0,5	0,9	1,4	0,3	yes
11.2 Risk Quantification	0,7	0,7	1,0	-0,2	yes

Table 5.12 Discrepancy for the category Peak Number of People Involved.

The variation were highest for the categories Budget and Project Duration, where the "D" value in the tables in both categories had to be set to 1,2 to single out 2 project management processes.

The number of times each process were registered to be in discrepancy with the total population, i.e. have a "yes" that singled the process out among the top four of the category discrepancies, may be a way to see which processes one should be careful to select for improvement without a further checking of category. Table 5.13 gives a summary.

Project Management Process	*Number of times the process by category had a "yes"*
5.1 Initiation	1
11.1 Risk Identification	2
10.1 Communications Planning	4
9.1 Organizational Planning	1
9.2 Staff Acquisition	4
5.2 Scope Planning	2
11.2 Risk Quantification	4
8.1 Quality Planning	2
9.3 Team Development	1
6.4 Schedule Development	0
8.3 Quality Control	1
7.2 Cost Estimating	0

Table 5.13 Number of times every process by category was among the top 4 with highest discrepancy to the total survey population.

Table 5.13 shows that the processes Communications Planning, Staff Acquisition, and Risk Quantification came up with highest dispersion or disagreement among the sub-categories.

Cross Analysis Conclusions

The presentation of the cross analysis have showed that each category more or less have sub-categories that are not in conformity with the total survey population. Consequently, some of the top 12 processes seems to be a less general candidate for improvement need than others, e.g. Communications Planning, Staff Acquisition, and Risk Quantification.

Conclusion

For the research problem 2, to indicate project management areas where improvement efforts like benchmarking should be focused, the research can in sum conclude with the following:

The project management processes performed early in the reference projects, i.e. initiating and planning processes, were identified to be of highest need of improvement. For the individual project management processes, the participants' answers indicate that following 12 had the highest need of improvement. In order of improvement need, the processes are:

1. Initiation
2. Risk Identification
3. Communications Planning
4. Organizational Planning
5. Staff Acquisition
6. Scope Planning
7. Risk Quantification
8. Quality Planning
9. Team Development
10. Schedule Development
11. Quality Control
12. Cost Estimating

5.6 DISCUSSION OF SOURCES OF ERROR

A survey will always carry potential sources of error, and this survey is no exeption. This section will review potential sources of error in the data used for deriving at the above conclusions to research problem 1 and 2. Andersen (1995) grouped potential sources of errors for his survey data into four categories:

- Sampling error

- Questionnaire error
- Respondent judgement error
- Human error

To categorize the sources of error this way is also suitable for this study's survey data. Some of these sources of errors where discussed and tried minimized in section 5.2 when designing the survey strategy. The potential sources of errors are discussed further below.

Sampling error

The first relevant question concerning errors was: Was the final sample of participants a good representative from the overall population of construction project management personnel?

The selection of the sample or the potential survey participants were made deliberately in an attempt to a.o. get a high number of returns. The strategy was to get a high number of returns or a high percent of the sample that responded. This is important for limiting the error that there are any likely differences in opinions between those who responded and those who didn't. The attempt was considered successful, when as high as approximately 45% of the questionnaires was returned (see earlier sections in this chapter). Even though this error was limited, it can not be ruled out that the not responding 55% did not have other opinions than the responding 45%. It might be that e.g. personnel from larger organizations consistently replied to the survey more often than smaller ones. Larger organizations with usually more resources to accommodate survey requests than small ones and the personnel from larger organizations may have very different opinion on project management processes than personnel from small ones. Thus, this may be a source of error that may have affected the data.

The strategy of getting a high number of returns, was made on the cost or expense of having a high absolute number in the sample, i.e. the number of potential participants were reduced. The actual number of participant became 46. This sample size of construction project management personnel was considered too little to draw definite conclusions for all construction management personnel . However, it was believed large enough to give strong indications with respect to construction project management personnel's opinion on PMI's project management processes, and with respect to improvement needs of individual processes. That the sample was large enough for such an indication was a subjective opinion that may be questioned. Thus, the size of the sample may have been a source of error.

The selection of the sample or the potential survey participants was made deliberately in order to target personnel knowledgeable in areas of interest to the survey. The strategy of targeting knowledgeable people was done to ensure quality in the answers. However, potential participants were identified by through contacts and subjective opinions. There are no guarantee that all respondents that returned the questionnaire actually had the desired knowledge that was wanted. The participants may also have

had a very dispersed level of knowledge, i.e. some knew little and some knew a lot about the desired topics. Thus, the quality of the sample, and variations in the quality within the sample, might lead to sources of error in the data.

Questionnaire error

Several potential sources for error are connected to the design and use of questionnaire for data collection. The individual questions may have been designed awkward, resulting in questions asking for something different than intended. Even if the questions were designed properly, the respondents might interpret them differently than was intended. Both of these sources of errors, i.e. awkward expressions and misunderstandings, would lead to erroneous transmitting of information from the participants to me. Such transmissions would lead to inaccurate or erroneous information in the data set.

In order to reduce this type of error, a heavy emphasis was put into designing the questionnaire. Experienced researchers from both Norway and USA assisted in the design and testing of the questionnaire. In addition, responding participants were encouraged to seek my advice to any unclear questions. Even if precautions were taken to reduce to these types of errors, it may be a source of error in the data.

Another source of error in connection with the questionnaire design, may be the load of information that is addressed to the participants. If the information in the questionnaire is too much, the respondent may discontinue the effort to fill out and return the questionnaire. Another option for the participant is to skip the reading of information, and go directly to answering the questions. This would lead to having participants answering questions without having the necessary information to answer them. Such answers would probably have a lower quality and the participants may give incorrect answers of their opinions. Both actions would be disadvantageous for the survey, the latter leading to an introduction of wrong data.

If the information in the questionnaire is too little, the participant may not have enough information to answer the questions in the intended way. Again, an introduction of erroneous data might occur.

The best way to have a balanced load of information and avoid this type of error is to have volunteers to test the questionnaire and give feedback. Three people volunteered for such testing, with resulting adjustions. However, people are different and there are also different opinions on “the correct load of information”. Thus, the load of information may lead to errors in the answers.

Respondent judgement error

The survey participants personal judgement could, intentionally or unintentionally, cause error in the set of data. The survey questions asked for subjective opinions regarding the PMI defined project management processes.

One source of error in this respect could be the terminology. Even if the used terminology was defined, the participant may misunderstand or disagree to the definition, or simply give a word meaning based on her own experience. Further, the terminology was written in English. Since more than half of the survey participants were from Norway and did not have English as their primary or daily spoken language, to relate to the language and terminology could cause a problem for many of the participants. Each Norwegian participant, and maybe also American, had to judge 37 project management processes, e.g. the schedule development process, and try to translate and relate it to a process from their own experience. Participants may have viewed a process differently, or viewed it to be another from the intended. The participants judgements could thus lead to errors in the set of data.

Another source of error related to participants judgement, is the scaling used for answering the questions. The participants were asked to give their answer on a scale from 1 to 5. The upper and lower scales contained no absolute reference points nor gave any absolute meaning themselves. The responses were therefore susceptible to subjective or expectation scaling. One participant may judge the scaling different from another. For instance, a Norwegian participant may consequently disregard to use the top and the lowest grade, and just use the middle range, while an American may consequently use the top and the lowest grade. However, having to rely on subjective opinions instead of objectively measured results, these types of errors would be hard to prevent. Participants' different judgements on the scaling, may thus have lead to inaccuracies in the data.

Human error

Human errors could at different points in the data collection and handling, result in errors in the data set. The participants could e.g. misread or mistype information when the questionnaire was filled out. Similar mistakes could have been made by myself when reading the data and typing it into the spreadsheets. Even if full concentration and double checks are executed, the presence of such human errors may have occurred. Thus, the data set may be subject to human errors.

In sum, there were several potential sources of error in connection to the gathering of data for this survey. A strategy of gathering the data among a selected population of experienced project management personnel with a believed knowledge of the survey topic, was decided upon to target quality in the answers and reduction of the overall errors. However, errors could be existent in the used data. The reader should keep this in mind while studying my findings.

PART 2: METRICS

6. IDENTIFIED RESEARCH AND LITERATURE ON METRICS

This chapter gives an overview on past researchers view on metrics. The first part focuses on general metrics issues that can help in organizing the development of metrics for project management process. The second part presents literature with significant contributions on metrics and specific metric suggestions that is relevant to this research of developing metrics to project management processes.

6.1 WHAT LITERATURE AND RESEARCHERS TELL US ON METRICS IN GENERAL

Measurements are key. If you cannot measure it, you cannot control it. If you can not control it, you can not manage it. If you cannot manage it, you cannot improve it. It is as simple as that (Harrington, 1991).

What is a metric?

The word *metric* is often used for quantitative information or measures employed in a Benchmarking. Qualitative information are usually also needed in Benchmarking. However, this study will focus on the quantitative information - the metrics. Metrics are not necessary used only in relation to benchmarking, but are often a quantified measure of. e.g. a process or performance that organizations use by themselves as a basis for decisions on how to go by to improve (Brown, 1996).

The word *metric* appears in many publications from the broad field of total quality management (TQM). Metrics in TQM has nothing to do with the metric system for measuring e.g. length. However, not many defines its meaning in full text. This study will use the definition used by the Construction Industry Institute (CII, 1996a):

> ***Metric: A quantifiable, simple and understandable measure which can be used to compare and improve performance.***

Categories of Metrics

Past researchers have categorized metrics in a number of ways. An overview of metric categories and groupings by past researchers that are relevant to this study is described in the following.

Tucker (1997) divides metrics into 3 general types:

- Anecdotal metrics- inexact and general measures created or influenced by e.g. Company PR.
- Subjective metrics - measures based on personal opinions.
- Objective metrics - measures based on actual measuring and facts.

"Sometimes you are not able find objective metrics and have to count on subjective metrics to measure the right thing. If you have enough of subjective metrics, they are as good as objective" (Tucker, 1997). This study will strive for finding objective metrics for the project management processes, but will use subjective metrics when appropriate.

According to Andersen (1996), there are 3 levels of information you can measure, i.e. 3 levels of metrics:

1. Performance metrics
2. Practice or process metrics
3. Enablers

For illustration of the different levels, Andersen gave an example from sport:
1. Performance Metrics: Measure the performance of a sportsman by placement against other competitors, time, length, style or similar.
2. Practice or Process Metrics: Measure the sportman's preparations and training i.e. the processes that lay behind the performance (e.g. diet, training equipment, different training processes).
3. Enabler: Measure for instance the economical, physical, political, geographical advantages of one competitor compared to another.

Andersen argued that for the purpose of benchmarking the latter level, enabler, is hard to measure and use in real life, but the two first are used and complement each other. Performance metrics and process metrics are of most relevance to this study, where the main focus will be on the latter.

Harrington (1991) groups the measure categories differently. He claims that process can be evaluated after 3 major categories: effectiveness, efficiency or adaptability:

- effectiveness: the extent to which the process outputs meet the needs and expectations of its customers(e.g. accuracy, performance, timeliness and costs)
- efficiency: the extent to which resources are minimized and waste eliminated in the pursuit of effectiveness (e.g. productivity and cycle time)
- adaptability: the flexibility of the process to handle future, changing customer expectations and today's individual, special customer requests.

As with most categories, when working in practice with metrics, there will be metrics that will have an overlap between the categories: effectiveness, efficiency and

adaptability. This study will try to concentrate on effectiveness metrics, but also involve efficiency metrics, so note their difference.

Evaluation Dimensions for Metrics

Another word for categorizing metrics on a higher level are dimensions. In Rolstadås (1995), Brederup suggest a consistent measurement model based on the three performance dimensions: efficiency, effectiveness and adaptability, by using the following categories of metrics:

- achievement metrics- direct metrics for business achievement;
- diagnostic metrics - indirect metrics for business achievement;
- competence metrics- capability of future business achievement.

However, these are categories of metrics on a company level, when this research focuses on process. Andersen (in Rolstadås, 1995) however, is process focused and states there are three main dimensions of process performance:

- Quality, often measured as defect rates or the process output's ability to satisfy the requirements.
- Time, generally time to execute steps in the process or time to deliver outputs from the process.
- Cost, either cost of performing steps in the process or cost of outputs from the process.

Organizing process metrics by dimensions like these, is a good way to sort and to keep an overview of the metrics in use. This research will make use of these dimensions, and add another dimension that is meaningful to most project management processes (which is resources).

Andersen further states that process performance measures used for benchmarking purposes, can be divided into two categories:

- Result measures, that describe the result of the process, often the quality, time or cost of the final output.
- Process measures, that describes how the process is performed, e.g., times for different sub-steps of the process, how many people are involved, equipment used, etc.

Both these two categories will be used in this research.

In an ongoing effort to establish a business macro performance measurement system, European ... (ENAPS) defines in a draft (ENAPS, 1996) performance measures along 5 dimensions:

1. Time,
2. Cost,

3. Quality,
4. Flexibility, and
5. Environment.

The first three dimensions are discussed earlier. Flexibility is what Harrington(1991) categorized in the adaptability group of measures, and will not be the focus of this research. The reason for not focusing on the flexibility/adaptability dimension, is that this is the most complex dimension which should not be targeted by this initial research on developing metrics for project management processes. The other dimensions are more clear to deal with and will be focused on.

Environment together with health and safety issues is of great concern to project management of many projects. However, it is not believed to be a dimension for each project management process. Environment belongs for the most on an overall project level more than on a process level and this research will deal with health, environment and safety on an overall project level.

Attributes of a good metric

Tucker (1997) lists attributes of a good metric, that may be collected at certain intervals by a company:

1. It is accepted as meaningful to the customer.
2. It tells how well an organization's processes and tasks fulfill its goals and objectives.
3. It is simple, understandable, logical and repeatable.
4. It shows a trend.
5. It is unambiguously defined.
6. Its data is economical(easy) to collect.
7. It is timely (data collection + turn around must be quick)
8. It drives the "appropriate action".

This list is a very useful tool and will be a guideline for this research when developing metrics.

Correct number of metrics

A number of publications agrees on using "vital few metrics" to evaluate the function or process in consideration, rather than "the trivial many" (Brown, 1996; Center for Quality Management, 1992; CII, 1996a). The recommendations vary between 12 to 20 metrics for an organization's overall measures. At a lower level, e.g. for processes, the recommendations are not so clear, but depending on number and type of the criteria there are for each process. For each criteria, recommendations are from 1 to three metrics:

"If you have a highly valid, highly feasible metric, then the choice is obvious. Use that one metric. If not, decide on two or three metrics."(Center for Quality Management, 1992).

Selection of Evaluation Criteria for Metrics

Before one look into what metrics there are to a process, one has first to decide what evaluation criteria the metrics are supposed to measure. CII (1986a, b, and c) defined some guidelines they followed when selecting criteria for evaluation of Design in construction projects. Adapted to processes, the guidelines to follow when selecting evaluation criteria would be:

- Evaluation criteria must be established at the beginning of the process - understood and accepted by all concerned.
- Evaluation criteria must (in that particular study) be used to evaluate process effectiveness (see 3 categories by Harrington above)
- Include only criteria with elements which directly impact attainment of project objectives.
- Process Performance goals should be reasonable and attainable, and achievements should be dependent primarily on the actions of those involved in the process.
- The criteria should cover all major aspects of the process responsibility.

Sources of complexity for evaluation and measurements in projects

What evaluation criteria that should be used for project processes depend on many variables. The many variables will all influence the selection of evaluation criteria and metrics. One project might have a different need of evaluation criteria and metrics than another. Based on CII (1986b), the following includes variables that affect or complicates the appropriateness of evaluation criteria and metrics :

- **Type of project.** A large grass-root refinery project may require different or additional criteria to those used to evaluate small building projects.
- **The project schedule**. A project with a crash schedule may require monitoring different criteria than a project with no special time constraints.
- **Type of contract**. Related to the schedule, type of construction or type of contract has a bearing on criteria selection. Often, fast track projects are performed with cost plus contracts; this and other differences between a lump sum contract and a cost plus contract might result in the use of different evaluation criteria.
- **The process customer**, or the user of the process output, must be taken into consideration when selecting criteria for evaluation of the process. Different stakeholders in the project have different interest in, and uses for, the process results. An owner selected criterion may be of less importance to a constructor evaluating e.g. a planning process. The owner may disagree on the relevance of some of the constructor selected criteria.

This research will try to suggest evaluation criteria and metrics that are general to most projects. However, it is up to the users of this research's suggestions to find the appropriateness of different evaluation criteria and metrics to their own projects and project management processes.

6.2 LITERATURE WITH PROJECT MANAGEMENT RELEVANT METRICS

This section will present 9 encountered publications with suggested metrics that are relevant to metrics for project management processes.

The first publication to be presented by Mark Graham Brown (Brown, 1996), is a whole book devoted to discuss the establishment of a business performance measurement system. It is the first and only encountered book covering metrics only. Brown suggest how one go by to define metrics for business performance in general. After years on consulting with major corporations on improving their performance, Brown has developed what he calls a new approach to measure organizational performance. The characteristics of his approach, are summarized in the following concepts:

- Fewer are better: Concentrate on measuring the vital few key variables rather than the trivial many.
- Measures should be linked to the factors needed for success, i.e. key business drivers.
- Measures should be a mix of past, present, and future to ensure that the organization is concerned with all three perspectives.
- Measures should be based around the needs of customers, shareholders, and other key stakeholders.
- Measures should start at the top and flow down to all levels of employees in the organization.
- Multiple indices can be combined into a single index to give a better overall assessment of performance.
- Measures should be changed or at least adjusted as the environment and your strategy changes.
- Measures need to have targets or goals established that are based on research rather than arbitrary numbers.

Brown lists several criteria categories for metrics, and give some suggestions for metrics. Some of the metrics and criteria categories suggested by Brown are put together in Table 6.1.

FINANCIAL PERFORMANCE • Economic value-added (EVA): measure the income as a ratio to investment. • Market value-added (MVA): all the capital the company has invested since it began divided by the market value of all the company's equity and debt. • Activity-Based Costing (ABC) • Cost of Quality (COQ): Measure the amount of labor and materials that is expended on rework or the correction of problems. • Return on assets (ROA):
EMPLOYEE PRODUCTIVITY • Dollars in sales/profit per employee. • Number of units produced per employee. • Number of units divided by labor costs. • Energy cost divided by production. • Number of units of good quality produced divided by raw material costs.
SAFETY METRICS • No. of lost-time accidents or No. of accidents. • Accident severity ratings. • Dollars spent in worker compensation costs. • Safety training and retraining • Safety audits (no., time, or cost) • Record evidence of unsafe practices, e.g. no. of near accidents.
CYCLE TIME • Cycle time of process or important tasks within process. Critical measure for any task because it equates to cost and satisfying customers needs.
FUTURE ORIENTED PROCESSES (LONG TERM MEASURES) • Investment in R&D. • Customer satisfaction. • Employee satisfaction. • Product or Service Quality. • Public responsibility (e.g. environmental, charity/community, ethics).
EMPLOYEE WELL BEING AND SATISFACTION • Employee morale survey. • Absenteeism. • Hours worked per week. • Turnover. • Grievances/Complaints • Requests for transfer (in and out of departments)
OTHER • Scrap or yield • Rework time and/or cost.

Table 6.1: Suggestions to measures for organizational performance, based on Brown (1996).

With the increasing use of metrics for monitoring and benchmarking, it was time for a book devoted alone to the topic. Brown suggest some good guidelines and new thoughts on measurements. Especially the financial measures are untraditional. These are financial measures focusing on the running of business, i.e. management, and not measures for creating wealth to its owner only. For management, Brown suggest that financial measures should cover all of the three perspectives: yesterday, today, and tomorrow. He warns against measuring the following traditional past- and present-focusing financial measures only, when they may not be good measures for running a business: Quarterly profits or earnings, Return on investment (ROI), Income and expenses, Cash flows, Stock prices, Accounts receivable or accounts payable.

Table 6.1 list most measures from the book relevant to project management processes, and will be used directly or indirectly by this research when developing metrics for each project management process. However, in a book fully devoted to metrics, it was disappointing not to find more specific metric suggestions or more examples of used metrics. It was especially few suggestions or examples for process metrics. Even though Brown has a focus on overall business performance, he emphasizes the importance of measuring processes. Still, he does not give examples of such process measuring. In addition, some suggested metrics are not defined well enough in the book. For instance for the metric economic value-added (EVA), Brown refers to a formula in a table in the book, but the formula is not in this table- nor is it defined or explained thoroughly in the text.

The second publication with metrics of relevance to project management and its processes, is a book by Harrington (1991). The book was on Business Process Improvement, that on the overview level covers measurement and metrics for processes well (see also earlier quotations of the author). From Harrington's book, the following is an extract of parts relevant to this research's metrics work.

Harrington emphasizes the importance of evaluating both external and internal customers needs and expectations. He lists what he calls customer needs and expectations that effectiveness measurements should reflect, related to process product or services. Further, he lists typical efficiency measures, which he argues indirectly affect process customers through effectiveness measures like costs and timeliness. Table 6.2. summarizes evaluation criteria for effectiveness measures and some efficiency measures from Harrington. This book gave many ideas for project management process evaluation criteria, but unfortunately few specific metric suggestions for project management processes.

Effectiveness Measure Criteria	Efficiency Measures
Appearance	Processing time
Timeliness	Resources expended per unit of output
Accuracy	Value added cost per unit of output
Performance	Percentage of value added time
Reliability	Poor-quality cost
Usability	Wait time per unit
Serviceability	
Durability	
Costs	
Responsiveness	
Adaptability	
Dependability	

Table 6.2: Effectiveness measures and efficiency measures based on Harrington (1991)

The thrird relevant publication is by NORSOK (1995), a combined effort by the Norwegian Government and the Oil & Gas industry of Norway to improve the profitability of North Sea welds, in order to among others, make a number of the previous not- developed smaller welds profitable and ready for development. The NORSOK report "Cost analysis and key figures" (NORSOK,1995) identifies and uses metrics to compare oil and gas offshore projects in the Norwegian sector of the North Sea with other parts of the world. Examples of the measures used for comparison are shown in table 6.3.

Balance price: Overall unit price (balance price) for total project and the contribution of each project phase to this: Discounted Annual Cost (USD) / Discounted Annual Production Volume(barrels)
Cost of Specific Project Activities versus Total Installed Cost (TIC), e.g.: Cost of Management as percent of TIC. Cost of Engineering as percent of TIC.
Other key measures: Cost of Administration & Design per design capacity (NOK/barrel) TIC per well(mill. NOK/well) TIC per design capacity(NOK/barrel) Design Capacity per well(barrel pr. day/well)

Table 6.3 Example measures for comparing Offshore Oil projects (NORSOK, 1995)

These metrics enables the Oil industry of Norway to compare the performance of it's projects with performance of projects in other parts of the world. These are good

overall project measures (metrics), but are not focused on project management and gives only ideas for some measures on project management process level.

The fourth relevant publication, is another source of project performance evaluation. It is a master thesis titled "Benchmarking of Project Management Performance in North Sea Oil and Gas Field Development Projects" by Jakobsen (1993, divided into a and b). This thesis evaluates and compares the performance of 4 projects in the North Sea. Jakobsen divides the project into different elements that he calls areas for evaluation. These areas are e.g. Total Project, Project Management, Engineering, Procurement, On-shore construction, Offshore construction, Topside and Subside of project. The measures Jakobsen uses for evaluation are divided in four categories:

Category 1: Cost growth, schedule slip and scope performance:
- Cost growth: [(actual cost/estimated cost -1) x 100%]
- Schedule slip: [(actual duration/estimated duration -1) x 100%]
- Scope performance: [(change order cost/estimated cost) x 100%]

Category 2: Distribution of Cost
- Cost Portion: [(cost of element/Total cost of project) x 100%]

Category 3: Distribution of Time
- Time Portion: [(duration of activity or area / Total project duration) x 100%]

Category 4: Performance indicators:
- Indicator 1: [Total Project Cost / (Topside Weight + Substructure Weight)]
- Indicator 2: [Topside Cost /Topside Weight]
- Indicator 3: [Substructure Cost / Substructure Weight]
- Indicator 4: [Topside Cost / Oil production Capacity]

Jakobsen does a good effort in establishing measures for performance of the project. However, the measures overall are not for Project Management as the title of the thesis would indicate, but some of these measures are relevant to project management. He states in his objective section:

> " ...the project management performance will be measured by measuring the performance of the project. A successful project indicates that the project management of that project has also been successful."

I disagree with this statement. The success of the project does not necessarily have a correlation with successful project management. There are many examples of successful projects with a not so successful project management. Vise versa, there are examples of projects that have had project management considered good, but the project result has been considered bad (See discussions in Chapter 2).

However, measuring the cost of project management and comparing it with total project cost is one good measure of project management, a measure Harrington (and now this research) would call a efficiency measure. Still, one measure alone is not enough and more project management measures, preferably on process level are needed.

The fifth encountered publication with metrics relevant to project management, is by the Construction Industry Institute and its Benchmarking and Metrics Committee (CII, 1996a). The publication is an additional source of overall project measures. The authors have for construction projects in general defined what they call critical few metrics along 5 dimensions: Safety, Schedule Performance, Cost Performance, Achieving Design Objectives, Customer Satisfaction. Their metrics, that are summarized in Table 6.4, are used to measure overall project and project phases. The project phases are defined to be: Pre-Project Planning, Detail Design, Procurement, Construction, and Start-up.

Metric category/ Metric	**Formulas**
COST Metric: Budget factor Metric: Phase Cost Factor (Owner data only)	• Owners: Actual Total Cost / Initial Predicted Cost • Contractors: Actual Total Cost / (Initial Predicted Cost + Approved Changes) • Actual Phase Cost / Actual Total Cost
SCHEDULE Metric: Schedule factor Metric: Phase Duration Factor (Owner data only)	• Owners: Actual Total Duration / Initial Predicted Duration • Contractors: Actual Total Duration / (Initial Predicted Duration + Approved Changes) • Actual Phase Duration / Actual Overall Duration
SAFETY Metric: Recordable Incident Rate (RIR) Metric: Lost Workday Case Incident Rate (LWCIR)	• RIR=total no. of recordable cases x 200,000 - total craft work-hours. • LWCIR = total no. of lost workday cases x 200,000 - total craft work-hours.
ACHIEVING DESIGN BASIS Metric: Attainment Factor	• Actual Product Output Rate at Acceptance Testing / Targeted Output rate for Acceptance Testing
CUSTOMER SATISFACTION Metric not yet defined	

Table 6.4: Summary of Metric categories and Metrics used by CII (CII, 1996a)

The use of the above metrics makes CII able to in a meaningful way to measure project performances among its members and non-members and identify best practices in project phases or on projects as a whole. This enables CII to guide its members to what parts of projects it should focus its improvement work in order to be better, including project management. However, the separation of project management from the project contents as a whole is not a CII focus. This research's focus on project management processes would better enable this separation between project management processes and project product-oriented processes (see discussion in section 2.2). This research adapts or gets ideas from the CII metrics to some metrics for the project management processes.

The sixth publication with metrics of relevance to this research, is another study by CII (CII, 1986c), brought to my attention by Tucker (1997). The publication is briefly touched upon earlier in this chapter. The study is an evaluation of design effectiveness in construction projects and has a lot in common with evaluation of other project processes, including project management processes. The publication with the title "Evaluation of Design Effectiveness" by R. L. Tucker and B. R. Scarlett identifies performance criteria to general areas important to all design users, regardless of construction categories, construction activities, or project variables. The authors identifies further the criteria that are important for their evaluation, i.e. the evaluation criteria, and assign metrics to each evaluation criterion. Table 6.5 shows all initially though of evaluation criteria. The evaluation criteria the researchers decided to use, are shown in the table with examples of used metrics.

Criteria	Metrics
Accuracy of the design documents	-Amount of drawing revisions versus total amount of drawings. -Amount of specification revisions versus total amount of specifications. -No. of revised specifications vs. total no. of specifications. -Reworked spools(drawing cylinders) vs. total spools. -Rework man-hours versus total man-hours.
Usability of the design documents	-Amount of field engineering man-hours per the total engineering man-hours (%). -Drawing size (assigned to a scale of 1-10). -Number of Drawings (assign. to scale of 1-10). -Clarity (subjective rating 1-10). -Completeness (subjective rating 1-10).
Economy of the design facility	-Subjective rating on a scale of 1 to 10.
Timeliness of the design/ Performance against schedule	-Number of design documents released at or before schedule versus total no. of design documents.
Ease of start-up (Start-up cost and time required)	-Actual start-up days versus budgeted start-up days. -Operator Man-hours, actual versus budgeted. -Maintenance man-hours, actual vs budgeted.
Cost of the design effort	-Actual design man-hours versus budgeted design man-hours. -Actual cost of design versus budgeted cost.
Constructablity of the design	-Subjective ranking on a scale of 1 to 10.
Completeness of the design documents	
Clarity of the design documents	
Operability of the design facility	
Maintainability of the design facility	
Safety of the design	
Plant Operating Efficiency	
Plant Performance	

Table 6.5: Evaluation Criteria and examples of metrics (CII, 1986c)

Many of the thoughts made in the CII report and the metrics listed above are adaptable to project management processes. Design is not listed by PMI in their project management processes, but for construction it was one of the processes that some this research's survey participants viewed as a project management process, and was listed

as a missing process. This research have had much use of the metric examples from the report, including the work summarized in Table 6.5. From literature, this CII study have given most ideas to this research's work in suggesting evaluation criteria and metrics for the PMI defined project management process.

The seventh publication that has given ideas to metrics for project management processes, is an article by Fisher, Miertschin and Pollock (1995) which summarizes Houston Business Roundtable efforts in establishing benchmarks for the construction industry. This study reports what was called 10 activities established through a survey to be most important for benchmarking to focus on. In order of importance, they were:

1. Actual versus authorized costs
2. Schedule: actual versus estimated
3. Scope changes
4. Engineering rework
5. Construction Labor. actual versus estimated
6. Field rework
7. Worker-hours per drawing
8. Project Cost distribution
9. Field defects
10. Percent of rejected welds

Reported metrics listed in this work are summarized in table 6.6 below:

Cost: Actual cost ($) / authorized costs ($).
Schedule: actual schedule (days) / estimated schedule (days)
Scope changes: Change orders ($) / Original Authorized Cost ($)
Construction Labor: actual (hours) / estimated (hours).
Worker-hours per drawing: Project Person Hours Spent / Number of drawings.
Percent of rejected welds: Number of rejected welds / Number of Radiographed welds
Employee turn over: Number of separations during month / Average number of employees on payroll during month (or mid-month employment) x 100.
Cost of quality /Deviation Correction (rework) The following was to be reported as approximate percentage of expended or earned person-hours (Terms defined by CII's Quality Performance Measurement Systems: QPMS): Normal work (of total work). Rework During Construction. Rework During Design. Quality Management During Construction. Quality Management During Design.

Table 6.6 Metrics based on Houston Business Roundtable study (Fischer, et.al, 1995)

The study was an initial try or preparations for a benchmarking in the Construction industry. Data for the above metrics were collected on a number of projects. After studying them, and reporting that e.g. the actual divided by estimated cost ratio for the overall community was 0,92, the authors draw some conclusions like:

> "This indicates a general tendency to slightly overestimate costs and thus have a project with a cost overrun. Assuming the ideal value is 1,0, the company with a project average closest to 1,0 may be the company with the most accurate cost-estimation procedure, and hence might be the company to benchmark against."

One might argue about this conclusion. One example of argument against this conclusion is that a company with 1,0 have cost estimates that are high, and the company tend to use all its monetary resources on a project before its end, i.e. the company is not cost efficient. It is hard to draw conclusions on one metric alone, which the above discussion proves. However, for evaluation purposes, it is very important to get some facts through measuring. Measuring 1 metric is a lot better than not measuring at all. Without measures and metrics one is totally dependent on subjective guesses and opinions. Even though Fisher, Miertschin and Pollock does not have an explicit focus on processes, their article gives many ideas for metrics to project management processes.

Measuring as an outsider or a third-party to a project, are different than measuring within or during the project in order to forecast progress and try to forecast and avoid trouble ahead. Many project management books contain this topic of *in-project metrics* to varying degrees of success. *In-project metrics* will just briefly be touched upon, when they will not be used actively in a benchmarking, but where the benchmarkers might just ask if these *in-project metrics* are used or not for control. The eigth publication presented here is by Ruskin and Estes (1995). They suggests three *in-project metrics* for periodic assessments in order to have warning signals for trouble ahead in a project:

1. The ratio of (a) the percent of the schedule and budgetary contingency allowances remaining to (b) the percent of project or project segment remaining *versus* time.
2. The ratio of (a) the cumulative number of substantially equal-sized work packages scheduled for completion by a given date to (b) the number actually completed correctly by that date *versus* time.
3. The number of change orders, anomalies, discrepancies, and other ad hoc items open divided by their respective rates of closure *versus* the amount of time remaining for their completion.

For Measuring Project Progress, Ruskin and Estes (1995) suggests the use of:

1. Percent complete which is the ratio of *work done* to {*work done+work to be done*} expressed as a percentage.
2. Earned valued which refers to the budgeted cost of work performed(BCWP). The term *earned value* comes from using BCWPs as the basis for payments from the customer to the project organization. BCWPs are used for more, including to determine if work is proceeding overall as scheduled, by comparing BCWP for a project or project element with its *budgeted cost of work schedule* (BCWS).

It is hard to distinguish if the above metrics can be used for in-project evaluation only, or if some can be used by a third-party for project evaluation. Some of the above in-project metrics are therefore adapted and listed as metrics for project management processes like e.g. Performance Reporting.

The ninth and last publication encountered with significant suggestions to metrics that are relevant to project management, is from evaluation of processes in the production environment, i.e. production management. The publication written in Norwegian by Stokland, Ørjasæter and Fagerhaug (1994), lists specific process evaluation criteria and metrics that can be borrowed directly or with small adjustments to project management processes. Twenty two - 22- production management processes are listed with suggestions for what in English would be called “Analysis area”, “Analysis techniques” and “Unit”, when translated from Norwegian. In this dissertation research report’s terminology, these words are close to evaluation criteria, metrics and metric units. Table 6.7 (A, B, and C) summarizes this publication’s processes and suggestions for measurements, that may be adapted or used for project management processes.

Process / Analysis Area	**Analysis Techniques**	**Unit**
1. Economic administration		
1.1 Budget management -Extent of the budgeting -Budgetary control	-Man-hours, No. of involved people in the budgeting work, No. of types of budget that is made(e.g. total, financial, liquidity, balance, costs, earnings) -No. of revisions, no. of control points, size of deviations, no. of change orders, no. of dispatched reports.	
1.2 Management after key economic figures -profitability figures -liquidity figures -solidity figures/financing -cost effectiveness	Frequently measures trends to give information. about: -return on capital, speed of capital circulation, etc. -liquidity, cash flows, etc. -turnover per man-labor year, added value per man-labor year	Ratio, share, %
1.3 Outstanding claims -Extent	- No. of matured outstanding claims, grouped after size and days since maturity. - Average time of credit per customer group, market segment or product group.	No., Days
1.4 Profitability -per product/product group -per customer group	-Contribution margin ratio, when possible cross examined for product and customer information. - Contribution margin ratio for the 2-10 most important customers.	
1.5 Turnover -per product/product group -per customer group	-Actual versus forcast, cross examined for product and customer information. -Two to 10 most important customers	
2. Personnel Administration and Team Development		
2.1 Salary -Wage developments, total, per personnel group etc. -Overtime payment, total, per personnel groups, etc. -Bonus benefits/payments, total, per personnel group, etc.	Time for negotiations, size of increase/decrease and/or the size of payments	Time, %, money

Table 6.7A: Criteria and Metrics suggestions from Stokland, Ørjasæter and Fagerhaug (1994).

Process / Analysis Area	**Analysis Techniques**	**Unit**
2.2 Sickness absence -absence due to sickness, total, per personnel groups, age-groups, departments, etc.	In percent of total working hours. Short and long term absence. Increasing short term absences often reflect a decrease in job-satisfaction.	Time, %
2.3 Personnel turnover -Total turnover, per personnel category, age-group, department, etc.	-Turnover defined: No. of personnel that has left and been substituted during a time period divided by No. of employees during the same period. -An increasing turnover can be a result of worsening job-satisfaction.	
2.4 Personnel statistics -No. in administration versus no. in production. -No. of own employees vs. no. of hired (own man-hours vs. hired man-hours) -Age-distribution in total, per department, org. level, etc. -Educational background and/or experience in total, per department, org. level, etc. -Length of employment in the firm in total, per department, org.level, etc. -Department, division, type of position, org. level, gender, etc.	From the company's personnel register or gathering of data: No. of people, no. of man-hours, or in %	
2.5 Competence -Plan for competence development -Activities for competence development. -Continuing Education -External training -Internal training	-To what degree does there exist plans for competence development anchored in real needs. -To what degree do one carry out appraisal interviews, continuing education, etc. -No. of courses/training attended in total or per personnel group.	Grade from 1 to 7, no., time, money, %.
2.6 Motivation -Job satisfaction -Appraisal interviews	-May do repetitive tests of opinions. -No. of interviews carried out per personnel group, resources used for these interviews. One could try through appraisal interviews to measure employees engagement and attitude to the job.	Index, no., No., time, money

Table 6.7B: Criteria and Metrics suggestions from Stokland, Ørjasæter and Fagerhaug (1994).

Process / Analysis Area	Analysis Techniques	Unit
3. Health, Environment and Security		
3.1 Accident statistics -Injuries and deaths -Frequency of injuries per personnel group, dept., etc.	-Number per type of injury, per type of personnel category. Number of hours of absence due to injuries.	No., time, money
3.2 Strain injuries - No. of strain injuries in a period -Costs due to strain injuries	-Number of registered injuries -Absence from work, treatments, insurance, etc.	No., money, time
3.3 Physical work environment/emissions -Concentration of dust, gas, steam -Noise level -Humidity, light, warmth, etc. -Emissions/waste	Can do physical measurements	mg/m3 ppm, dB(A), %,°C, etc.
3.4 Complaints/Inquiries -No. of complaints with regard to HES questions from external environment (Public offices, neighbor, etc.) -No. of complaints from employees with regard to HES questions	Register no. of complaints categorized after type of complaint, where the complaint came from, etc.	No.
4. Selection from other processes		
4.1 Plans -Ability to develop and use overview plans(strategy plans, business plans, development plans, etc.) -Ability to set quantifiable goals	-To what degree these plans are developed, are known, and followed -Go through how quantifiable the firms goals are.	-Grade 1 to 7 -Grade
4.2 Strength of actions -Realization of goals/scope -Planned efforts and initiatives that are accomplished	-Number of goals that are met in a period. -Number of defined initiatives in plans. No. of accomplished initiatives in a period. No. of initiatives turned down. (Accomplished initiatives in a period) by (no. of planned-no. of turned down) *100	No., % %

Table 6.7C: Criteria and Metrics suggestions from Stokland, Ørjasæter and Fagerhaug (1994).

6.3 CHAPTER CONCLUSION

In sum, this chapter can be concluded with the following:

No metrics encountered in litterature or existing research were developed for project management processes directly. Furthermore, no set of metrics were encountered that directly focus on project management only.

Several of the metrics developed in existing work on metrics and benchmarking, e.g. project metrics, may be similar to metrics that can be used for some project management processes. However, the existing metrics do not amount to fill in for all processes, and they need to be adjusted or adapted to the relevant project management process.

There are several ways to categorize and develop metrics. This research's focus on development of metrics for project management processes requires a slightly different approach than previous research's categorization, because this research is an attempt on development of metrics in a new area, i.e. project management processes. A structure for how this research will categorize and approach the development of project management process metrics, will be presented in the next chapter.

7. METRICS WORK AND SUGGESTIONS

This chapter will explain the approach and work of this research to develop metrics to project management processes. Further, it gives a presentation of this research's developed suggestions to metrics that are general for all project management processes, and suggest specific metrics along the quality dimension.

7.1 RESEARCH STEPS AND RESEARCH APPROACH

The purpose of the metrics research was described in chapter 3. In sum it is to suggest metrics to project management processes, that can be used by potential benchmarkers to get ideas for measures for their own project management processes.

The following steps shows the approach of this research to develop suggestions to metrics for project management processes:

1. Literature and previous research was studied with respect to inputs on evaluation dimensions, evaluation criteria and metrics.
2. Four meaningful evaluation dimensions for project management processes was decided upon as a framework for this research.
3. Along these 4 dimensions, evaluation criteria and metrics was suggested, based on a combination of studied literature and own creative thoughts.
4. For the three dimensions Time, Cost and Resources, it was possible to define general metrics that quite well covers all project management processes. The dimension Quality was more complex and it was here harder to define general project management process metrics. Specific metrics individual for each of the 37 PMI defined project management processes was desired. Even if some specific metrics for individual project management processes could be found in literature, it was far from enough. It was decided to get ideas for quality evaluation criteria and quality metrics specific to each project management process through interviews with 10 people experienced in project management.
5. Based on a combination of the interviews, literature, and own creative thoughts, metrics were suggested to all 37 project management processes (Research problem 3 addressed).
6. For a test of the metrics work, a project management processes was chosen partly based on the previous survey of the project management processes perceptions. The metrics work to this project management process was tested by asking survey participants of their opinion.

Figure 7.1 below tries to illustrate the above described research steps of the way this research went by to define metrics for a project management process.

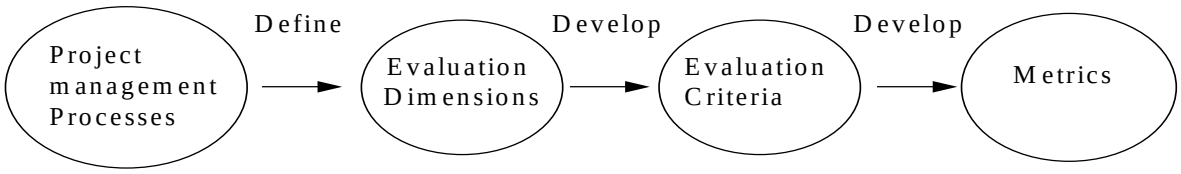


Figure 7.1. Illustration of this research's approach to define metrics for a project management process.

Research Limitations

A project management process may have a large number of potential evaluation criteria with their own set of metrics. The appropriate evaluation criteria and metrics for a project management process will depend on the specific project. This research will try to define metrics for the project management processes defined by PMI, which is currently the most general and best available set of project management processes encountered by this research (see chapter 4).

This research will first define feasible dimensions for evaluation of project management processes, then suggest evaluation criteria, and finally define practical metrics for project management processes. The amount of potential evaluation criteria and metrics are limited by imagination only. A focus had to be decided upon to try to cover the most meaningful evaluation criteria and metrics, only. With reference to the discussions of existing literature in the previous chapter, this research constrained itself within the following:

- Focus on quantitative information, i.e. metrics, that can be used in a benchmarking study.
- Focus on project management processes, and not other parts of project management.
- Use the 37 project management processes defined by PMI as a basis to identify and develop evaluation criteria and metrics. Even if there are some shortcomings to the PMI set of project management processes, it is probably the best available, and it was perceived quite well by the survey participants (See chapter 5).
- Try to develop objective metrics, but use subjective metrics whenever appropriate.

- Effectiveness metrics will be the focus of this study, although an overlap to efficiency and adaptability metrics may occur, while it is hard to keep within the overlapping borders of these conceptual categories (see literature from Harrington).
- Enablers will not be looked into, but the research will concentrate on performance and process metrics (see literature from Andersen)
- A vital few metrics will be tried selected- do not want too many for each process and criteria.
- Try to suggest metric that are easily understandable.
- Focus on evaluation criteria that are valid for most project management processes, regardless of type of project. Further, focus on what for many projects in general can be critical few metrics for the evaluation criteria. Will not try to develop a complete set of metrics to each project management process, which is probably impossible due to the many variables between different projects.
- Although evaluation criteria and metrics will be sought developed for all 37 PMI defined project management processes, some processes may end up with less complete evaluation criteria and metrics than other processes. It is not an objective to evenly focus on all processes.

7.2 THIS RESEARCH'S SUGGESTIONS FOR METRICS

Evaluation Dimensions, Evaluation Criteria and Metrics for All Project Management Processes in the PMI Set

With reference to described various dimensions and categorizations of metrics from literature and to the limitations of this research, Figure 7.2 shows what this research suggest to be the 4 meaningful dimensions to establish evaluation criteria and metrics along when focusing on project management processes

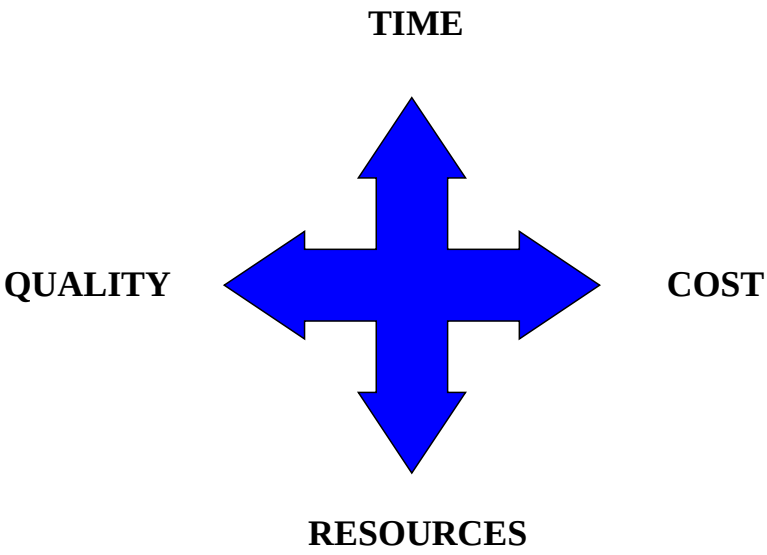


Figure 7.2 The 4 suggested Evaluation Dimensions to find Evaluation Criteria and Metrics along, for each of the individual project management processes.

All 4 dimensions may not apply to all 37 processes, but will be relevant to most of the processes. Additional dimensions may be necessary to measure some processes. Along the above 4 dimensions, Table 7.1 to 7.4 shows suggestions to general evaluation criteria and general metrics for all 37 project management processes. The suggestions are based on a combination of literature and own creative thoughts.

In addition to the mentioned 4 dimensions to establish evaluation criteria and metrics Table 7.5 suggests some measures for overall project/project management that might be useful for benchmarking and/or measuring of project management processes.

TABLE 7.1: TIME

Criteria	Metric
Effectiveness: Timeliness of the process (performance against schedule):	Record if the process met schedule (yes/no), or ratio: $\frac{\text{Actual Duration of Process}}{\text{Estimated Duration of Process}}$ The process duration can be substituted by duration of important activities or tasks in the process.
Efficiency: How long time to do the process, (compared to rest of project)?	Raw no. of Process Cycle Time, or ratio: $\frac{\text{Actual Duration of Process}}{\text{Total Project Duration}}$

TABLE 7.2: COST

Criteria	Metric
Effectiveness: Cost of the process effort (performance against initial budget)	Record if the process met initial budget (yes/no), or ratio: $\frac{\text{Actual Cost of Process (approx.)}}{\text{Initial Estimated Cost of Process}}$ The process cost can be substituted by cost of important activities or tasks in the process. Cost can be substituted by approximate figures on earned value or income.
Efficiency: Cost of process, (compared to rest of project).	Raw no. of approx. Process Cost, or ratio: $\frac{\text{Actual Cost of Process (approx.)}}{\text{Total Project Cost}}$

TABLE 7.3: RESOURCES

Criteria	Metric
Effectiveness: Resources used, (performance against plan):	Record if the process met planned man-hours (yes/no), or ratio: Actual No. of man-hours used in Process Estimated/planned No. of man-hours in Process The process man-hours can be substituted by man-hours of important activities or tasks in the process. Man-hours can be substituted by cost of personnel, equipment, or materials.
Efficiency: Resources used in the process, (compared to rest of project).	Raw no's. of Process man-hours, or ratio: No. of man-hours used in the process Total no. of man-hours involved in Project

TABLE 7.4: QUALITY

Criteria	Metric
• Accuracy of the process/ output. • Completeness of the process output • Clarity of the process output. • Usability of the process output.	Record if the process/ output met needed accuracy, completeness, clarity, usability, by: • Qualitative or quantitative subjective opinions of process customer and/or process personnel (lengthy answer, yes/no, or by grade 1 to 5.) • Rework time and/or cost. • Change order amount, due to the process. • Other measures specific to each process and output. Note: For suggestions to process specific quality criteria and metrics, see tables suggesting specific quality metrics in the next section.

TABLE 7.5 OTHER CRITERIA AND METRICS USEFUL FOR MEASURING AND BENCHMARKING OF PROJECT MANAGEMENT PROCESSES, AND PROJECTS AND PROJECT MANAGEMENT OVERALL

Criteria	Metric
Health, Environment, Safety Safety in the process and of the process product/output: Injuries and deaths due to project/process.	Record raw numbers, • lost time accidents • no. of accidents and/or injuries • money spent in worker compensation cost • no. of near accidents or ratios: $\frac{\text{No. of work-related injuries or deaths}}{\text{No. of personnel}}$ Lost/restricted work-days due to work related health hazards divided by no. of personnel
Job satisfaction, or Customer and stakeholder satisfaction	Opinion surveys (qualitative or quantitative). Turnover Sick-leaves/absenteeism
Complaints: Effectiveness	$\frac{\text{Actual no. of complaints}}{\text{Estimated no. of complaints}}$
Efficiency	No. of complaints by project external people, possibly versus size of project. Note: Complaints could be categorized by e.g. project internal, project external groups (neighbors, public offices, etc.)
Productivity of process/project	Start to measure or take samples in order to estimate: • Outputs per unit • Actual no. of productive hours per week. • Number of units produced per employee. • Number of units divided by labor costs. • Productivity/activity sampling: randomly short-time observations of productivity/activity by personnel group.
Profitability	• Return on investment: Raw no. or actual versus estimated. • Dollars in profit per no. of personnel. Other financial measures (see list from Brown, 1996)

General PM	• Do the company have a PM Handbook? If yes,: how many pages and is it appreciated/used? • Compare own PM measures/metrics with those of other firms/projects. • Software and tools for PM and cost control.
Leader-/ownership	Is there a designated process owner? (Yes/No)
Flexibility of process / output	Subjective opinions about how flexible the project/process is to meet new demands.
Stakeholder Participation	Raw no. of Participating parties, perhaps versus project size or no. of parties complaining

7.3 THE QUALITY DIMENSION

In the tables above, general evaluation criteria and metrics were suggested along the 4 evaluation dimensions, Time, Cost, Resources and Quality. However, it was hard to find general suggestions along the dimension Quality. Quality of processes and process outputs depends more on the specific process than for the other dimensions. It was decided to try to develop metrics for each project management process along the quality dimension for each project management process. For the purpose of benchmarking, it is not enough with quantitative measures, i.e. metrics, of quality. Qualitative measures are needed as well. However, this research's metrics development attempt along the quality dimension focused on quantitative measures.

Interview inputs from experienced project management personnel

In order to obtain a broad view on important quality evaluation criteria and metrics to all of the 37 PMI defined project management processes, it was decided to ask experienced project management personnel to give their opinion and suggestions. Ten- 10- experienced project management personnel were interviewed. Eighth from Norway and Two from United States. The participants are listed in Appendix A.

In advance of the interview, all participants received the figures illustrating the PMI set of project management process (Figures 4.1 to 4.7), along with a brief explanation of what was to be asked in the interview. Due to the confidentiality of the interviews, the minutes for each interview are omitted from this report. The inputs from the interviews were summarized into one document, sorted after the most relevant project management process. Due to its lengthy character the complete interview document will not be published in this dissertation report. However, inputs to 3 processes are given below as a sample of the complete interview document.

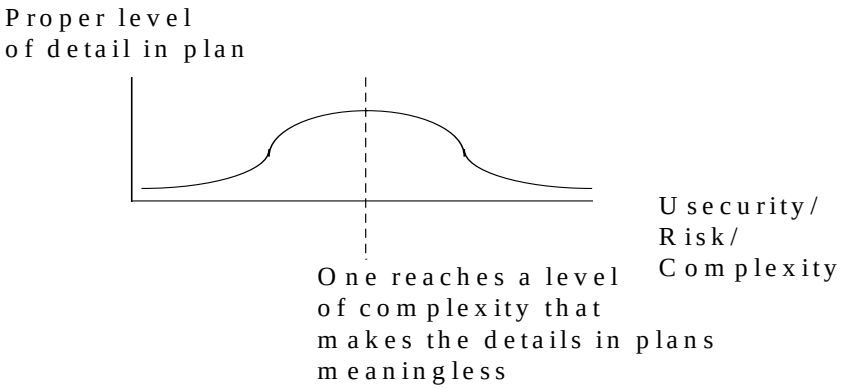
SAMPLE OF INPUTS FROM INTERVIEWS: Inputs to the Project Management Knowledge area, Project Integration Management, and its three project management processes.

4. **Project Integration Management**
A subset of project management that includes the processes required to ensure that the various elements of the project are properly coordinated. It consists of:

4.1 **Project plan development**— taking the results of other planning processes and putting them into a consistent, coherent document.
Evaluation criteria:

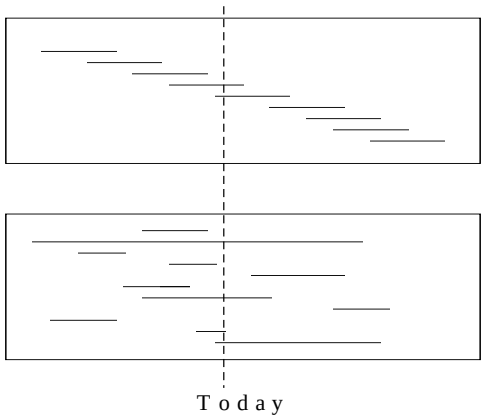
1. A project work plan that are highly educational (pedagogic). Make the plan on different pedagogic levels, so one are able to communicate with all stakeholders in the project.
2. Focus in plan on strategic connection/communication as e.g. decisions that are going to be made outside of the project's decision authority.
3. A project plan should only give the necessary focus on what to do, and therefore should everything in the plan be done.
4. Pitfall that one ends up at to high/overview level or at to principle level. It is not operationalized such that it gives concrete guidance and answers in connection to the execution of the project.
5. The basis for the project (the needs the project are to fill) are well analyzed and understood by the people making the plan.
6. All levels have to make their own plans that becomes incorporated into PM's overview plan. This is the time for sub-levels to give feedback if time and cost can be kept. Incorporate feedback into new plan.
7. Take the time needed to make the plan. We are often pressured on time (and cost)- to get done with the plan-, but it is important to resist the pressure in order to have time to make a good plan. Without a good plan, one looses quickly the overview and then the possibility to follow up the plan.
8. Difficult to get a integration between cost and plan. "Are we using more or less than budget?"- a figure often used for control, but it does not really tell the project progress. Look e.g. at purchasing: "At this point in time, have we spend more or less on purchasing than planned?" It does not include the actual progress: maybe there are items that should have been bought but have not been 100% bought, but only 50%. We have the cost-wise figure, and need to have the details of the actual progress on purchase- therefore not real management information. - To be able to manage you have to do the hard task of integrating cost in plan with the progress. It is successful when budget tools and project management tools are integrated, i.e. have the same structure for cost and plan at activity or work package level.
9. Participation in planning for the people that are going to carry out the plan. Never have some third party make your plan. The ones that are going to carry out the plan should also plan the details in the plan.
10. The plan is a fundamental factors in projects: If one have a good plan, a lot will go by itself. With a bad project plan ,where you have thought about half of the activities, you can put in the best Project Managers but it will not help a lot.:
11. A good plan has made sure that it has everything that shall be included.
12. A good plan is thought through and thought about what can go wrong and look at countermeasures.
13. A good plan shows that the project is not alone. The plan includes project surroundings and contextual issues.
14. Gather enough information about the task in the plan before you plan in detailed. Key word: the Stepwise process by Sten Lichtenberg. One should plan at an overview level for the whole project and plan detailed only for the closest period, because the project will change all the time. Wait with

the details! You do not know enough about details far ahead and if you plan for this details, the plan becomes unrealistic. Deterministic estimates for time and cost for a detail far ahead tells us that the plan is bad. Unnecessary fixation of the plan, reduces flexibility and increases the no. of changes and work in updating plans. How far ahead one should plan detailed, have of course to do with the insecurity or risk the project are exposed for. Is it a repetitive project (done one similar before) or is it a unique project? The figure below illustrates a theory given in the interview: Most of the time, the farther away a task is in a project, the higher is the uncertainty about how the task is going to be done. With very low uncertainty, the proper level of detail is quite low. When the uncertainty increases the proper level of detail does too. The proper level of detail increases until one reach a level of complexity/uncertainty that makes the further detailing of the plan meaningless. From this point of uncertainty and up, the proper level of detail will be reduced accordingly to the way it increased.



15. Two important criteria for a plan to be able to manage and communicate thoroughly: 1) From top to bottom, activities are successive in time. 2) Activities have about same length in time. Two extremities (se figures below - top a good plan, the one below confusing): The top schedule are preferable because activities are time-wise successive from top to bottom and are about the same length. The lower schedule are confusing, because the starting point of the activities is set randomly and the length of activities vary too much. If one activity is too long compared to the others, it should be broken up to same level and get approximately same length. The lower plans exist due to budget and organizational reasons. So the lesson to learn, think project management when making

the plan.



Metrics or Key Measures:

- For specific types of projects, measure time used for planning processes, and compare with overall project duration and time used for other processes.
- Measure activity lengths:
    - average length of activities. After some measures you get a figure for correct length compared to project type. E. g. average activity duration should not be more than 25 days on a $300 mill project.
    - variance in the length of each activity in the project.
- Measure the time-wise sucessiveness of the activities:
    - Starting from top in a schedule, measure raw number of times an activity starts before the previous activity (and compare it to total no. of activities)
    - Starting from top in a schedule, sum up the "negative" time between one activity to another (and compare it to a figure like total project duration or duration of all activities)
- Measure the detailness of tasks far ahead in plan. Define the middle of the project time-wise. Count and compare no.of activities before the middle and after the middle. When you measure this on a type of projects for a while, you will find an appropriate percentages of activities before and after middle. (If the no. of activities after middle are as high or higher than the no. of activities before, it is probably planned too detailed for activities far ahead.)
- Measure no. of items that should have been in the plan, but is forgotten (Raw no. or no. for specific categories).
- Number of changes to the plan. (See the cost and schedule development processes)
- No. of people complaining. Raw no. of people complaining after construction starts or no. of people complaining of not have being heard (involved) during planning.
- No. of parties involved and the diversity of parties involved during planning compared to previous or similar projects.

4.2 **Project plan execution**—carrying out the project plan by performing the activities included therein.
Evaluation criteria:

1. Evenly distribute your efforts. Is the project of long duration or short? Manage or employ your strength as you would in a race. Do not rush in a marathon.
2. Motivate project participants by e.g. film and take pictures of the work.
3. Follow up your plan with fixed periodic meeting for coordination e.g. once a week, and update plans.

4. If everything goes as planned, have the plan then been to kind? It is wrong that everything goes as planned- the plan was then bad. E.g. We ask our selves if we do the right things. The plan says yes, so we are fine- but the reality is that the plan was bad, we could have done the same things e.g. a lot quicker.
5. A plan is deterministic, if you have 1 week to do an activity- you use one, if you have two weeks to do the same activity, you use two.
6. There are some things one has control over, other things not. Set a right focus at the things you do not have control over (public authorities, project stakeholders, steering committees, building commission, etc.). Problem by all the project external people that have something to say about the project- they all want to affect(change) the plan at least at one issue- it destroys the plan.
7. Do not combine progress with payments (paid costs). Need to measure each separately. Progress is measured by deviation to plan, not on cash outgoing.
8. Make prototypes of e.g. quality so one does not have to argue about if the item is good or bad. E.g. The first electric outlet is studied, and becomes the target gauge(standard for the 200 others). 1000 sq. meter floor covering- lay the first 100 sq. meters and agree on if this is good enough for the remaining. Wherever an agreed on standard is possible, it should be done.
9. Milestones: Put focus on critical points or milestones in the project. Motivate against the milestones. Make a short and even distance between the milestones.

Metrics or Key Measures:

- How close am I following the plan? Measure how close you follow the schedule, earned hr. versus budgeted hr., materials costs, major construction equipment costs?
- Measure distance between milestones. Average and variance.

4.3 **Overall change control**—coordinating changes across the entire project.
Evaluation criteria:

1. Look forward, not backward. Concentrate on deviations/changes that will influence activities ahead. Forget about past history (and spilled milk).
2. Do changes of plan only after evaluation of relevant criteria- understand the consequences to the project for each change. Ideal would be to just accept changes when one see a gain in profitability of doing it, or if there are alignment improvements in Safety, health, and environment, towards laws or other project external conditions.
3. A defined change order process is important. Consequences of changes must be evaluated before the change is made. Do not handle a single invoice that have not been ordered (in writing). Have a accumulated list over changes during project- you manage after changes.
4. Make the change order system quick enough. Often, the system takes too long time, so changes are evaluated and decisions are made on the spot with unforeseen consequences.
5. Take care of the positive part of changes- changes are not only bad, but can give increased profit, too.
6. Two types of changes: 1) Changes to meet initials goals usually due to errors in the Engineering and Initiating Process. 2) Changes due to changes in goals (e.g. mill. 500 gallons a day is increased to mill. 750 gallons a day. It's a change in scope)
7. Type of contract. Big difference in how change data is collected based on: A. Cost reimbursable contract. B. Lump Sum Contract. In A., Contractor has always been paid by hours, so changes are not as important to them. Owners don't document changes in A (we need to pay for it all anyway). Just having a system there to collect changes, would be a major step forward for the company.

Metrics or Key Measures:

- Raw no. of Changes

- No. of times the changes have been made at the spot, without the approval.
- Cost (and time) of waiting for change to be approved.

Please note that the interviews were conducted by going through the whole PMI set of project management processes, one process after the other. Each participant were free to focus or elaborate on some processes, and disregard or skip others. In this way, some project management processes were discussed and covered in length, while others were more or less neglected. As a result, the evaluation criteria and metrics inputs to some processes were lengthy, while others were brief. The input to the above shown processes were quite long compared to other processes. One process, Scope Change Control, did not get any direct input from the interviews.

Finding what process each input belonged to, was not always an easy task. For some input given in the interviews, it was obvious which process it belonged to. Other input were harder and could belong to many processes, or did not really belong to any process. The sorting was done subjectively by myself, and could thus have been sorted differently if done by others.

The interviews gave either direct suggestions to evaluation criteria and metrics for the quality dimension, or they gave ideas that combined with the encountered literature gave creative thoughts that resulted in suggestions for evaluation criteria and metrics. Not all of the given inputs were used towards creating evaluation criteria and metrics. A selection was made, based on the constraints of this research.

The Quality Metric Suggestions

Below are listed all 37 project management processes defined by PMI, listed by project management knowledge area, with suggestions for metrics. The metrics (measures) are suggested along the dimension of quality, respectively to its evaluation criteria like accuracy, completeness, clarity, usability, and correctness. However, it was not possible for all project management processes to correlate each metric to one evaluation criterion, while the metric frequently overlapped several criteria. Furthermore, the 4 defined evaluation dimensions were created to simplify the research or reduce its complexity. There is an overlap between these 4 dimensions. Even though the quality dimension is in focus, there might be suggestions to evaluation criteria or metrics that just as well could belong to the other dimensions.

The following tables focus on quantitative measures, i.e. metrics, whenever possible, but they contain several suggestions to questions for qualitative measures also. A few processes have suggestions for qualitative measures, only. Some measures may be valid for several processes, but is for space and overview reasons tried listed only once. When looking for metrics to one process, check therefore with neighboring processes within the project management knowledge area, and/or other processes relevant to the process in question.

The metrics in the following tables are suggestions along the quality dimension that can be used by potential benchmarkers and project management process measurers as a starting point to define metrics for their own processes.

4. Project Integration Management
A subset of project management that includes the processes required to ensure that the various elements of the project are properly coordinated. It consists of:

4.1 Project plan development—taking the results of other planning processes and putting them into a consistent, coherent document. Process output is project plan.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Total no. of changes to the plan due to mistakes during planning. • No. of items that should have been into the plan, but was forgotten (Total no. or no. for specific categories). • No. of items that was in plan, but should not have been. • No. of parties that have had a say (and party diversity) during plan development (compared to previous or similar projects.) • No. of people complaining to the plan. Raw no. of people complaining after construction starts or no. of people complaining of not have being heard (involved) during planning. • Distance between milestones. Average and variance. Should be an even distance. • Ask of subjective opinions or measure the detailness of tasks far ahead in initial plan. Define the time-wise middle of the project (50% of project duration). Count and compare no. of activities before and after midpoint. $\frac{\text{No. of activities before midpoint}}{\text{No. of activities after midpoint}}$ Ratio should be >1, but how much will depend on project. When measuring the ratio on a type of projects for a while, an appropriate percentage of activities in initial plan before and after middle will be found. If ratio < 1, the plan is probably to detailed in the end, and should not be because uncertainty is high there. Activities late in the project should be detailed and incorporated into plan after more information is gathered, usually in project execution when you know more. This way you keep flexibility in the project, and no. of changes and updates to plan down. (see 6.4 Schedule Development for more) Ask for qualitative or quantitative(grade 1-5) subjective opinions on how well the plan is put together (see interview summary for info. on important criteria)

4.2 Project plan execution—carrying out the project plan by performing the activities included therein. Process output include work results and change requests.	
Criteria	**Metric**
Accuracy, completeness	Raw no. or ratio of: • Rework cost and/or time (divided by total project cost and/or time). • Approved changes: 1) no. of changes due to change of scope, 2) no. of changes to meet initial goals usually due to errors in planning and initiating processes. Cost and/or time of change orders (divided by total project cost and/or time). • Frequency of project meetings for coordination. • No. of violations to legal, environmental and safety regulations. Measure how close the plan is followed. Deviations to e.g.: • schedule and milestones, • earned hours versus budgeted hours, • materials cost, and • major equipment costs. Ask for qualitative or quantitative(grade 1-5) subjective opinions on how well the plan is executed: • if integration between cost and time(progress) in plan is well. • if budget and project management tools (software) is well integrated. (see interview summary for more info. on important criteria) Note: See also 10.3. Performance Reporting.

4.3 Overall change control—coordinating changes across the entire project. Process output includes project plan updates, corrective action and lessons learned.	
Criteria	**Metric**
Accuracy, usability	• No. of times the changes have been made at the spot, without approval. $\frac{\text{No of changes done without approval}}{\text{Total no. of changes}}$ • Cost and/or time of waiting for change to be approved (divided by project cost and/or project time). • Average time (and range or variance) from change request is sent to approval is made. • Frequency of updates to the plan. • Ask for qualitative or quantitative(grade 1-5) subjective opinions on how well the changes are updated in the plan. Are the updated plans used? (see interview summary and project measures for more info. on important criteria) Note: See also other controlling processes

5. Project Scope Management: A subset of project management that includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. It consists of:

5.1 Initiation—committing the organization to begin the next phase of the project. Process output includes project charter and project manager identified/assigned.

Criteria	**Metric**
Accuracy, completeness, usability	Raw no. or ratio on involvement or agreement between project stakeholders: No. of stakeholders represented in initiation work / Total no. of project stakeholders No. of decision makers wanting to stop project / No. of Decision makers wanting to. go further • Agreement on PM assignment (e.g. no. of candidates, votes for or against). • No. of meetings, time and/or cost spent on defining project charter and/or written contract with project manager (if any). Key figures that measure the successfulness of project result: • Actual versus estimated Return on investment and other financial measures (see general project/ process suggestion) • Actual versus estimated project output (e.g. barrels per day, cost per m2 floorage, cost per kilometer of highway, cost of major installed equipment). Ask for subjective opinions about e.g. • the decision to initiate was a correct decision? • how well you find PM qualifications and clarity of project charter for this project? (see interview summary in Appendix for more info. on important criteria)

5.2 Scope planning—developing a written scope statement as the basis for future project decisions. Process output includes scope statement and scope management plan.

Criteria	**Metric**
Accuracy, completeness, clarity, usability	Raw no. or ratio on involved project stakeholders: No. of stakeholders represented in scope work / Total no. of project stakeholders • No. of changes due to changes in scope. • Change order cost and/or time, or ratio:. Change order cost (or time) due to scope changes / Total project cost (or time) • Time spend to discuss project scope with project customer(s). • Time from initiation decision to signature of project customer(s) on scope statement (and scope management plan). Ask of subjective opinions: • How clear do you find the scope statement and the scope management plan?

	• How well are competing sub-goals defined against each other, i.e. prioritized (e.g. cost versus time or environment)? • How well is the scope/goal stated in measurable terms? Count no. of measurable terms if possible.(see interview summary in Appendix for more info. on important criteria) • Are there any unnecessary constraint set to the goal? (see interview summary in Appendix for more info. on important criteria)

5.3 Scope definition—subdividing the major project deliverables into smaller, more manageable components. Process output is the work breakdown structure (WBS).	
Criteria	**Metric**
Accuracy, clarity, completeness, Usability	Ask for subjective opinions among stakeholders and project personnel: • Is it clear what you need to do to help achieve the project goal? • Is it clear to you what others are to do? • How well structured and detailed is the WBS? • Conformity of scope: Is the WBS in your opinion an illustration of the same scope as in the scope statement? Record no. of times there are discussions during the project on who is going to do what.

5.4 Scope verification—formalizing acceptance of the project scope. Process output includes formal acceptance of work results.	
Criteria	**Metric**
Accuracy, completeness	Ask for subjective opinions: • Was the inspection of the work results, before formal acceptance, satisfactory? • Conformity of scope. Is this work result what was asked for in the scope statement?

5.5 Scope change control—controlling changes to project scope. Process output includes scope changes, corrective action and lessons learned.	
Criteria	**Metric**
Accuracy, completeness	No. of changes due to scope changes (see also processes 5.2 and 4.3) Ask for subjective opinion and check on conformity of scope in documents: Is the same scope traceable in all documents from scope statement to project finish, i.e. no uncalled for scope changes?

6. Project Time Management: A subset of project management that includes the processes required to ensure timely completion of the project. It consists of:

6.1 Activity definition—identifying the specific activities that must be performed to produce the various project deliverables. Process output includes activity list and WBS updates.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	Identify and record raw no.'s or ratio: $\frac{\text{No. of activities outside project control (e.g. decision activities)}}{\text{No. of activities within control of the project.}}$ • No. of important activities later found to have been forgotten. • No. of critical activities, i.e. activities critical in cost, complexity, time, risk, etc., versus total no. of activities. • No. of activities close to start-up of every project phase (get only an overview of activities later in the phase, not so important or maybe wrong to have all activities defined in detail. See process 4.1. for more). • No. of activities judged to the size of the project. (Two different persons might respectively schedule same project to e.g. 100 and 500 activities. This say something about the quality. After measuring a while one will find numbers on appropriate level of detail.) Measure: $\frac{\text{Total no of project activities}}{\text{Total project cost (or duration)}}$ Ask for how one go by to identify activities, e.g. use of experienced personnel, reference project, database.

6.2 Activity sequencing—identifying and documenting interactivity dependencies. Process output includes project network diagram.

Criteria	**Metric**
Accuracy, Usability, Clarity	Record raw number of changes to the logic sequencing of activities, or ratio: $\frac{\text{Number of changes to the logic sequencing of activities}}{\text{Total no. of activities}}$ Ask for subjective opinions: • Project plan should focus on important dependencies. How well are weak or loose dependencies kept loose, in order to maintain flexibility to the way the project is run? (For other important criteria to process, see interview summary in appendix):

6.3 Activity duration estimating—estimating the number of work periods which will be needed to complete individual activities. Process output includes activity duration estimates and basis of estimates.

Criteria	**Metric**
Accuracy, Completeness,	Compare raw no.'s or ratios: $\frac{\Sigma(\text{Actual Activity Duration})}{\Sigma(\text{Estimated Activity Duration})}$

	Σ(Actual activity duration minus estimated activity duration) Total Project Duration No of activities that have actual duration as planned or shorter Total no. of activities Ask of use of experience database for estimation and how one go by to come up with estimate.

6.4 Schedule development—analyzing activity sequences, activity durations, and resource requirements to create the project schedule. Process output includes project schedule, schedule management plan and resource requirement updates.	
Criteria	**Metric**

Accuracy, Completeness, Usability, Clarity	Measure number of changes to schedule (If changes to many, more than 10%- e.g. if 90% change it is a poor schedule):
	• Are there many changes in activity duration?
	• Are there many changes in resources per activity?
	• Raw number of changes to the baseline schedule.
	• No. of changes in activity logic
	• Compare number of changes to the schedule versus total number of activities.
	Measure ratios:
	No. of initial planned activities with duration less or equal to planned
	Total no. of initial planned activities
	
	Actual Project Duration
	Estimated Project Duration
	
	Actual Project Duration
	Estimated Duration (baseline) + Duration of Approved Changes
	
	Total no. of changes in schedule
	Total no. of activities in schedule
	
	• No of important activities later found to have been omitted during schedule development.
	• No. of changes in activity contents (activity is done another way than estimator & planner believed)
	• Measure planned activity lengths:
	  • average length of activities (over time you get a figure for correct lengths compared to project type and size, e.g. average activity duration should not be more than 25 days on a $300 mill project.)
	Σ(length of Activities)
	No. of activities
	  • variance (or st.dev.) of activity lengths in the project (should be low, i.e. break up activities that are much longer than others).
	Measure the time-wise sucessiveness of the activities:
	• Starting from top in a schedule, measure raw number of times an activity

	starts before the previous activity (and compare it to total no. of activities): $\frac{\text{No. of times an lower activity starts before an higher activity}}{\text{Total no. of activities}}$ • or, Starting from top in a schedule, sum up the "negative" time between one activity to another (and compare it to a figure like total project duration or duration of all activities): $\frac{\Sigma(\text{length in time when a lower activity starts before the preceding})}{\text{Total project duration (or duration of all activities)}}$ Ask for way to develop schedule: Experience of schedule developer, use of software and tools, reference project, experience database, etc.

6.5 Schedule control—controlling changes to the project schedule. Process output includes schedule updates, corrective action and lessons learned.	
Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	Record: • Time from change is approved until updated for activities and milestones in work schedule. Calculate time average and variance for a number of change orders (see 4.3 Overall Change Control) Ask: • If schedule is regularly updated and change orders timely incorporated in schedule and milestones? • How well progress can be read from the combination of cost and schedule. • For use of earned value techniques: the Schedule Performance Ratio(SPR) from S-curve techniques that measures schedule efficiency during the project: SPR = Earned value/Budget • For use of percentage complete and other progress tracking techniques.

7. Project Cost Management: A subset of project management that includes the processes required to ensure that the project is completed within the approved budget. It consists of:

7.1 Resource planning—determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities. Process output includes resource requirements.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	Decide on a no. of important resources and compare: $\frac{\text{Actual Quantity}}{\text{Estimated Quantity}}$ Example: If estimate for concrete was 1000m3 and actual 1300m3, i.e. ratio 1,3, it was not a good estimate. Calculate ratio average, range and/or variance(st.dev.) for all important resources. (See Table 7.3 Resources) • No. of times in a project when work stops or is redirected due to significant lack of resources. • Time delays (or cost of time delays) due to lack of resources

7.2 Cost estimating—developing an approximation (estimate) of the costs of the resources needed to complete project activities. Process output includes cost estimates and cost management plan.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	Decide on a no. of important resources and compare: $\frac{\text{Actual Unit Price}}{\text{Estimated Unit Price}}$ Example: If estimate of concrete was $1 a barrel, and actual was $3, i.e. ratio is 3/1=3, it was not a good estimate. Calculate ratio average, range and/or variance(st.dev.) for all important resources. (See Table 7.2 Cost) Ask about way to come up with estimate (use of experience database, experienced personnel, software, tools, etc.)

7.3 Cost budgeting—allocating the overall cost estimate to individual work items. Process output includes cost baseline.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	Record overall raw no. or ratio: $\frac{\text{Total amount of Contingency}}{\text{Total Budgeted Project Cost}}$ For important contracts or cost items: $\frac{\text{(Tender + Cost of changes)}}{\text{(Estimated cost of Contract (or cost item)+ contingency)}}$

<table>
<tr><td colspan="2">7.4 Cost control—controlling changes to the project budget. Process output includes revised cost estimates, budget updates, corrective action, estimate at completion, and lessons learned.</td></tr>
<tr><td>Criteria</td><td>Metric</td></tr>
<tr><td>Accuracy, Completeness, Usability, Clarity</td><td>Brake project down in % complete (at e.g. 20%, 25%, 50%, 75%, 90% and 100%) and compare at these points the ratio:
$\frac{\text{Actual cost}}{\text{Original budget}}$
• Was Cost loaded schedule(CLS), baseline budget developed for the job based on the schedule, used? Yes/No(CLS gives an idea of how the money will be spend).
Did project hit targeted use of contingency? Measure for total project or important activities:
$\frac{\text{Used contingency}}{\text{Planned contingency}}$
Did we reach targeted profit? Measure:
$\frac{\text{Actual profit}}{\text{Planned profit}}$
• Time from change is approved until budget is updated. Calculate time average and variance for a number of change orders (see 4.3 Overall Change Control)
• Time from work item is approved until payment is made to contractor.
Depending on sort of agreement between project customer and the project organization, measure delays of payment:
Sum: (Actual time of payments - Supposed time of payments)
Ask if Project Cost Management Analysis concepts are used:
• During the project, measure the Cost Performance Ratio (CPR) from S-curve techniques that measures cost efficiency: CPR = Earned value/Actual Cost.
• Percentage complete or other measures.</td></tr>
</table>

8. Project Quality Management
A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of:

8.1 Quality planning—identifying which quality standards are relevant to the project and determining how to satisfy them. Process output includes quality management plan, operational definitions and checklists.

Criteria	**Metric**
Accuracy, Correctness, Completeness, Clarity Usability	Check if time set of for quality control is a part of the main stream activities or does it exist as a parallel system? Yes/No. (one key criteria: quality control must be a part of the activities in question and not in parallel where it will be forgotten). Measure raw no. or ratio: $\frac{\Sigma(\text{time set aside in plan on quality checkpoints during the project})}{\text{Total no. of quality checkpoints}}$ • Record no. of checkpoints and milestones and their dispersion through the project. Key criteria: should be spread out quite even.

8.2 Quality assurance—evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards. Process output includes quality improvement.

Criteria	**Metric**
Accuracy	Measure raw no.'s or ratio: $\frac{\Sigma(\text{actual time used on quality checkpoints during the project})}{\Sigma(\text{Estimated or time set aside in planning for quality checks})}$

8.3 Quality control—monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance. Process output includes quality improvement, acceptance decisions, completed checklists, process adjustments and rework (rework is action taken to bring a defective or non-conforming item into compliance with requirements or specifications).

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Record raw no. of change orders and/or change order cost/and or time. • Percentage scrap or yield of resources (e.g. materials, equipment) • Raw no. of reworks, or ratios:. $\frac{\Sigma(\text{cost of reworks})}{\text{Total Project Cost}}$ or $\frac{\Sigma(\text{time of reworks})}{\text{Total Project Time}}$ Note: Instead of total project, rework comparisons can be used for important work items in project. (See 4.3 overall change control for more)

9. Project Human Resources Management: A subset of project management that includes the processes required to make the most effective use of the people involved with the project. It consists of:

9.1 Organizational planning—identifying, documenting, and assigning project roles, responsibilities, and reporting relationships. Process output includes role and responsibility assignments, staffing management plan and organization chart.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	Subjective opinions only: • Ask X no. of project people: How well is the role and responsibility assigned on this project? • Ask X no. of project people: How well covers the staffing management plan the personnel needs, like e.g. a plan for dismissing of project personnel?

9.2 Staff acquisition—getting the human resources needed assigned to and working on the project. Process output includes project staff assigned and project team directory.

Criteria	**Metric**
Accuracy, Completeness, Usability	Record or measure: • Turnover of personnel, raw no. or ratio: $\frac{\text{No. of unscheduled separations during a time period}}{\text{Average no. of employees on payroll during same period}}$ • Time and/or cost of delays due to missing personnel. • Time and/or cost of having more people than planned(needed) on project.. • Experience of personnel: $\frac{\Sigma(\text{time key personnel have been in the same level of responsibility})}{\text{Total no. of key personnel in question}}$ • Subjective opinion surveys. • Ask X no. of project people: How well are new project personnel systematically introduced to the project, including project history, project goals, status towards the goals?

9.3 Team development—developing individual and group skills to enhance project performance. Process output include performance improvements and input to performance appraisals.

Criteria	**Metric**
Completeness, Usability, Clarity	Record or measure: • Absenteeism: No. of days project personnel call in sick, or ratio: $\frac{\text{Total no. of days personnel was away from work for a time period}}{\text{Average no. of personnel for same period}}$ • Training/continuing education: Raw no.'s or ratio: $\frac{\text{No. of days project personnel has received training for a time period.}}{\text{Average no. of personnel for the same period}}$ • Turnover of personnel, raw no. or ratio:

	No. of unscheduled separations during a time period Average no. of employees on payroll during same period • Frequency of late time to work (no. of times) and/or average late time (minutes). • No. of teambuilding(TB) retreats or efforts on project (kick-off meeting with everybody involved, no. of times one get outside of workplace), or ratio: (No. of TB efforts x No. of personnel participating in the TB) Average no. of personnel in the period in question • Subjective opinion surveys. • Ask personnel: How free do you feel to tell about problems and deviations in project? How well is the alignment of goals among project stakeholders?

10. Project Communications Management: A subset of project management that includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information. It consists of:

10.1 Communications planning—determining the information and communications needs of the stakeholders: who needs what information, when will they need it, and how will it be given to them. Process output is communications management plan.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	• Breakdown of communication: 1) Raw no. of breakdowns, 2) delays due to breakdown in time (or cost) • Delays of equipment, materials or personnel shows up late due to miscommunication (in raw no. of times, Cost or time of delay) • Subjective opinions. • Ask X no. of project people: Did you receive enough or to little information on the project (both formal and informal info.)?

10.2 Information distribution—making needed information available to project stakeholders in a timely manner. Process output includes project records.

Criteria	**Metric**
Accuracy, Completeness, Usability	Each project personnel start to record: • No. of documents received, but did not need (and what kind of documents). • No. of known important documents not received or received to late, that was needed/wanted. Project record start to record: • Time from documents are sent to received (average, variance). • Raw no.'s or ratio: $\frac{\text{No. of documents distributed on project in total or for a period}}{\text{Average no. of project personnel on total project or for the period}}$ • Opinion surveys on how well informal information is distributed.

10.3 Performance reporting—collecting and disseminating performance information. This includes status reporting, progress measurement, and forecasting. Process output includes performance reports and change requests.

Criteria	**Metric**
Accuracy, Completeness, Clarity	• Measure actual versus planned performance to find if job is progressing good or bad. Performance reports = monthly billings - quantities performed in the month x original unit price. • For segments of project, track status of change orders versus time: $\frac{\text{No. of approved change orders}}{\text{No. of not approved change orders}}$ • Similarly track status of the material submittals for project segments:

	No. of sent material submittals where materials not yet is received No. of closed submittals (when materials received) versus time. When late with preparation of submittals, makes late with order of materials. Ratio tries to measure this. With an increasing ratio, start to prepare submittals earlier. • Start to make a curve of reported estimated profits to home office versus time during the project. If curve(estimated profits) drops towards the end of project, it might be that PM has been hiding the problems to look like he is performing good with a hope of making it up later in the project. If curve (estimated profits) go higher at end, it might be a conservative PM hiding money in case anything goes bad later in the project. If curve is about horizontal (i.e. estimated profits remain constant) during the lifetime of the project, you know that reporting has been good. • For project, project segment or important activities, start to record and plot the following ratio: Schedule (& budgetary) contingency allowance remaining in % Project, (project segment or activity) remaining in % versus time. If the ratio is 1,0 or bigger for a number of recordings, allowance is OK. If ratio is 1,0 and dropping with time, the project will likely run out of allowance before work is done, i.e. no allowance will remain to correct mistakes that occur later in project, which is unsatisfactory. • For equal-sized work packages (ESWP), during project start to record cumulative ratio: (Total No. of ESWP scheduled for completion by a given date) (Actual no. of ESWP completed correctly by that date) versus time. If the ratio of cumulative no. of ESWP is greater than 1,0 and growing with time, the schedule will likely expire before all the work is done, an unsatisfactory outcome. Ask for subjective opinion on the use of: • Percentage complete: ratio of *work done* to{*work done+work to be done*} • Earned Value Techniques. Including, earned value (budgeted cost of work performed(BCWP) as the basis for payments from the customer to the project organization, but also to see if work is proceeding overall as scheduled by comparing BCWP for a project or project element with budgeted cost of work schedule(BCWS).

10.4 Administrative closure—generating, gathering, and disseminating information to formalize phase or project completion. Process output includes project archives, formal acceptance and lessons learned.	
Criteria	**Metric**
Accuracy, Completeness, Clarity	• Status of punch list. When project is almost completed, project customer is going through a list (punch list) of things that needs to be done. Measure raw no. or ratio:

	Cost spending on punch list items(or a defined last part of project) Total project cost • Ask for subjective opinions of the quality of this process.

11. Project Risk Management: A subset of project management that includes the processes concerned with identifying, analyzing, and responding to project risk. It consists of:

11.1 Risk identification—determining which risks are likely to affect the project and documenting the characteristics of each. Process output includes sources of risk, potential risk events and risk symptoms.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	• Start to record no. of any major surprises or unforeseen risk items in the project, that was not identified during planning (and/or the resulting cost and/or time of the item) $\frac{\text{No. of unexpected sources of risks+planning omitted sources of risk}}{\text{No. of sources of risks identified during planning}}$ $\frac{\text{No. of occurred unexpected risk events+planning omitted potential events}}{\text{No. of risk events identified during planning}}$ • No. of parties (organizations, functional units, groups) involved in and/or that gives input to project risk. • Make a risk list with a probability of occurrence and estimated cost of occurrence, that is the basis of the estimated total project contingency allowance. Measure no. of risk item on the list and/or ratio: $\frac{\text{Actual used contingency allowances}}{\text{Estimated use of contingency allowances}}$ • Ask for subjective opinions of the quality of this process.

11.2 Risk quantification—evaluating risks and risk interactions to assess the range of possible project outcomes. Process output includes opportunities to pursue -threats to respond to, and opportunities to ignore- threats to accept.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	Record raw no.'s or ratios: $\frac{\text{Actual cost and/or time of risk items occurred during project}}{\text{Estimated cost and/or time of risk items occurred}}$ $\frac{\text{No. of risk-related injuries or deaths during project}}{\text{Average no. of project personnel}}$ $\frac{\text{No. of lost/restricted work days due to risk occurrence}}{\text{Average no. of project personnel}}$ $\frac{\text{Actual gains in money value due to occurred positive risk events}}{\Sigma\ (\text{Estimated prob. of occurrence x est. gain of occurrence})}$ $\frac{\text{Actual cost in money due to occurred negative risk events}}{\Sigma\ (\text{Estimated prob. of occurrence x est. cost of occurrence})}$

11.3 Risk response development—defining enhancement steps for opportunities and responses to threats. Process output include risk management plan, contingency plans, reserves and contractual agreements.	
Criteria	**Metric**
Completeness, Usability, Clarity	Record raw no.'s or ratio: Σ (contingency offset to risk item/contingency used for risk item) no. of risks in question When you start to record these numbers, you will find appropriate numbers for risk on similar projects. (see also process 11.2 and 11.1 above) Subjective opinions. Ask project personnel: • Were there any opportunities (risks) for the project that you did not take advantage of? (risk has both a positive and negative side) • Were there any risks that you took where you did not sufficiently understand the consequences?

11.3 Risk response control—responding to changes in risk over the course of the project. Process output includes corrective action and updates to risk management plan.	
Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Cost and/or time of waiting for risk response action to be decided/approved (divided by project cost and/or project time). • Time from risk occurred(or action approved) to the project plan is updated. • Is an independent, i.e. third party, control calculation on extremely important project issues done, like e.g. an independent verification that the building will not collapse if build as planned? Yes/No. • Ask for subjective opinions of the quality of this process.

12. Project Procurement Management: A subset of project management that includes the processes required to acquire goods and services from outside the performing organization. It consist of:

12.1 Procurement planning—determining what to procure and when. Process output include procurement management plan and statement(s) of work.

Criteria	**Metric**
Accuracy, Completeness, Clarity Usability	• No. of (handable) contracts that the project is divided into versus size (time, cost or no. of personnel) of project. • Ask for subjective opinions of the quality of this process.

12.2 Solicitation planning—documenting product requirements and identifying potential sources. Process output include procurement documents, evaluation criteria and statement of work updates.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Record raw no. or the ratio(average no. of identified potential sources): $\frac{\Sigma \text{ (No. of identified potential sources for a project segment)}}{\text{No. of project segments}}$ • Ask for subjective opinions of the quality of this process

12.3 Solicitation—obtaining quotations, bids, offers, or proposals as appropriate. Process output includes proposals.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Record raw no. or ratio: $\frac{\text{Actual no. of obtained quotations, bids, etc. for a project segment}}{\text{Planned no. of obtained quotations, bids, etc.}}$ $\frac{\Sigma \text{ (No. of obtained quotations, bids, etc. for a project segment)}}{\text{No. of project segments}}$ Note: "no." in the formulas can be replaced by cost and time. • Ask for subjective opinions of the quality of this process

12.4 Source selection—choosing from among potential sellers. Process output includes contract.

Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• Record raw no. or ratio: $\frac{\text{No. of times the lowest bid is assigned the job or sale}}{\text{Total no. of jobs or sales}}$ Note: Record reasons for decision when not obtaining the lowest bid. • Ask for subjective opinions of the quality of this process

12.5 Contract administration—managing the relationship with the seller. Process output includes correspondence, contract changes and payments requests.	
Criteria	**Metric**
Accuracy, Completeness, Usability, Clarity	• No. of change orders (perhaps divided by size of project, i.e. cost, time or no. of personnel) • Record yes/no if there exist a contract administration manual (and yes/no to important parts of its contents). • During project, for whole contract or for a specific time period, record and track ratio: $\frac{\text{No. of open items like change orders, anomalies, disagreements, etc.}}{\text{No. of closed items (change orders , anomalies, disagreements, etc.)}}$ versus time. If the ratio is larger than 1,0 and increasing with time, the closing rate of these ad hoc work items is insufficient, and the project will likely not meet its objectives. The PM should re-plan the project in order to have a compatible set of objectives. • Ask for subjective opinions of the quality of this process. For instance ask for use of partnering and integrated team concepts.

12.6 Contract close-out—completion and settlement of the contract, including resolution of any open items. Process output include contract file, formal acceptance and closure.	
Criteria	**Metric**
Accuracy, Completeness, Clarity	• No. o f reworks, or rework cost and/or time as a percentage of total project cost and/or time. • Status of punch list. When project is almost completed, project customer is going through a list (punch list) of things that needs to be done. Measure raw no. or ratio: $\frac{\text{Cost (or time) of punch list items(or a defined last part of project)}}{\text{Total project cost (or time)}}$ • Time from date of project organizations request of formal handover to project customer, to actual date of formal handover, i.e. retainage, the proof of all project work done. • Record yes/no if project customer (maintenance) personnel are involved for checks and training before handover of project product, and how long(days) they were involved. • Ask for subjective opinions of the quality of this process.

7.4 SUGGESTION ON HOW TO USE THE LISTED METRICS

The above tables with metrics for project management processes along the 4 suggested evaluation dimensions, may be used in any way that seem meaningful, as long as the criteria and metrics taken from them are adjusted and adapted to the project management process in question. However, there might be misunderstandings on the use of the suggested metrics. Therefore, as a starting point or example to potential benchmarkers or project management process measurers, this research suggest one way to use the metrics listed in the tables, in order to develop metrics for own project management processes.

1. Decide on and define the project management process for consideration (starting/ending points, outputs, etc.).
2. Decide on the dimensions that are meaningful to this process (Cost, time, resources, quality).
3. Decide on and list evaluation criteria of this process you want to measure (e.g. effectiveness, efficiency, flexibility, performance, in-process activities or enablers)
4. If you already have some ideas of metrics or other sources of metrics to some of the criteria, define and list the metrics with their respective criteria.
5. Look at this document's tables with listed criteria and metrics, and see if there are criteria or metrics you may use. Remember to adjust the criteria and metrics to fit your own process. The tables may give ideas of additional criteria and metrics that are important to the process in question.
6. Step 6: You will probably have too many criteria and metrics for the project management process. If so, start to rank the criteria and metrics, e.g. by validity and coverage, to reduce the numbers to an appropriate level, i.e. a vital few.

The next chapter will show a test of the developed metrics to one of the project management processes.

8. FEEDBACK ON THE METRICS WORK

This chapter presents an effort to get a feedback on the metrics work. The feedback is given through a survey where experienced project management personnel were asked of their opinions to metrics work for one selected project management process. The preparations and results of this survey are presented. Further, the sources of errors are discussed and the chapter ends with conclusions.

8.1 PREPARATIONS

A feedback on the metrics work in this part 2 of the dissertation was planned and decided to arrange. The most obvious way to get a feedback was to ask the participants from survey part 1 of their opinion to the work on developing metrics to project management processes.

In the questionnaire to survey part 1 (see Appendix B), it was stated that the survey part 2 had the purpose of evaluating this research's suggested metrics to a selection of project management processes, where the selection of processes should be based on the answers in survey part 1. However, when the research got this far, there were discovered that both the metrics work and the suggested metrics had become more complex and larger in size (quantity) than expected. The dissertation research has made suggestions to metrics for all 37 PMI defined project management processes. Due to time and space constraints, it was out of the question to present a large number of the 37 processes with their suggested metrics to the survey participants and ask for their opinion.

In order to reduce the amount of metrics work material presented to the participants, it was decided to ask for opinion of metrics work to only 1 of the 37 project management processes. The feedback from this survey part 2, could not automatically be generalized to the metrics work on all project management processes. However, a project management process that were quite similar in type to the other processes, i.e. a process that was representative of all 37 processes, could make the feedback a little more general. As stated earlier, it was also important to focus on project management processes in high need of improvement.

In survey part 1, the participants were asked for their opinion on the importance and performance to 37 project management processes defined by PMI by giving a rate from 1 to 5 (see Appendix B and chapter 5). A central point of the analysis of the survey was that a project management process with high importance and low performance, is unsatisfactory performing and should be in the focus of improvement. The 12 project management processes with the highest value when deducting average performance from average importance, are shown below in decreasing order of the deduction value, i.e. in order of the highest need of improvement:

1. Initiation	5. Staff Acquisition	9. Quality Planning
2. Risk Identification	6. Scope Planning	10. Schedule Development
3. Communications Planning	7. Risk Quantification	11. Quality Control
4. Organizational Planning	8. Team Development	12. Cost Estimating

Risk identification, the process that ranked no. 2 in improvement needs, was assumed to be a good representative of the 37 project management processes and the metrics work on them. This process was therefore chosen to be asked for feedback. The reason for not taking the no. 1 ranked initiation, was that this is a very special and complex process that was not believed to be a representative process.

Having decided on Risk Identification to be the project management process to ask for feedback, the next step were to study the tables with listed suggestions of metrics. While looking at the metrics tables, partly following the suggested prescription in section 7.4 on how to use the list of suggested metrics, I got new ideas for evaluation criteria and metrics that resulted in some additions and changes. This exercise ended up in 6 evaluation criteria and metrics selected for survey part 2. The full questionnaire, Questionnaire to Survey Part 2, is shown in Appendix C, along with an additional letter that was sent out to avoid misunderstandings. Below is an extraction from the survey, showing the suggestions for Evaluation Dimensions, Evaluation Criteria, and metrics to the project management process Risk Identification:

For measuring the effectiveness of the process Risk Identification, this dissertation research suggest to measure/record the raw numbers and/or ratio of the metrics below, that may use approximate numbers when necessary. Please do not respond to the questions in the up-right corner, before they are asked in the questions section at the last pages.

Metric 1 Weight(%) ____ How Good? ____
Dimension: TIME
Evaluation criteria: Timeliness of the process (performance against schedule):
Metric:

$$\frac{\text{Actual time spent on process}}{\text{Estimated time (schedule offset) for process}}$$

Metric 2 Weight(%) ____ How Good? ____
Dimension: COST
Evaluation criteria: Cost of process effort (performance against initial budget).
Metric:

$$\frac{\text{Actual cost spent on process}}{\text{Estimated cost (budget offset) for process}}$$

Metric 3 Weight(%) ____ How Good? ____
Dimension: RESOURCES
Evaluation criteria: Resource efforts of the process (performance against planned man-hours)
Metric:

$$\frac{\text{Actual no. of man-hours used in process}}{\text{Estimated man-hours (plan offset) for process}}$$

Metric 4 Weight(%) ____ How Good? ____
Dimension: QUALITY.
Evaluation criteria: Accuracy/completeness of the identified sources of risks(omitted versus identified)
Metric:

$$\frac{\text{No. of unexpected sources of risks, and sources of risks omitted during planning}}{\text{No. of sources of risks identified during planning}}$$

The formula can be enhanced by categorizing the sources of risks not only in total, but by internal, external, and safety related sources of risk, and/or multiply the sources of risks in question with a subjective severity rating from e.g. 1-3 (pick 1 when severity is low, 3 when severity is high, and 2 when somewhat in between).

Metric 5 Weight(%) ____ How Good? ____
Dimension: QUALITY
Evaluation criteria: Accuracy/completeness of the identified potential risk events (omitted versus identified).
Metric:

$$\frac{\text{No. of occurred unexpected risk events, and potential risk events omitted during planning}}{\text{No. of risk events identified during planning}}$$

Similarly as for metric 4, the formula can be enhanced by categorizing the potential risk events not only in total, but by internal, external, and safety related risk events, and/or multiply the potential risk events in question with a subjective severity rating.

Metric 6 Weight(%) ____ How Good? ____
Dimension: QUALITY
Evaluation criteria: Accuracy: Do project hit targeted offset for risks (contingency allowance)?
Metric:

$$\frac{\text{Actual used contingency allowance on project}}{\text{Estimated contingency allowance, or offset to meet risks on project}}$$

The formula can be used for cost and/or time

8.2 THE RESULTS OF SURVEY PART 2

The questionnaire for survey part 2 was sent to all 48 participants that replied on survey part 1. Of these 48 experienced project management personnel, 22 replied, which means that 45,8 percent took part in this survey part 2. Unfortunately was two of the responses incomplete with very few answers given, and had to be taken out. The

final number of participants was thus 20. The participants to survey part 2 are marked *in List of participants to the interview and the survey* in Appendix A.

With reference to the questionnaire Figure 2, (identical to Figure 7.2) where 4 meaningful dimensions to evaluate/measure PM processes in general are suggested, in sum the following two questions were first asked:

Question 2: Can you think of any missing evaluation dimensions that is meaningful to find metrics along for each of the 37 PM processes?

Question 3: Are any of the 4 evaluation dimensions, suggested to be meaningful to find metrics along for each of the 37 PM processes, superfluous?

With reference to the 6 suggested evaluation criteria, and provided a restriction to a critical few evaluation criteria (4-8), the two next questions were:

Question 4: Can you think of any evaluation criteria that are missing?

Question 5: Do you find any of the 6 evaluation criteria superfluous?

As in survey part one, the participants were asked to pick their answer on a scale from one to five, where five was "No, not at all", one was "Yes, indeed", and the middle range was defined to be "somewhat in between". Table 8.1 below shows the mode, median, average, and standard deviation of the answers to the four questions.

	Q.2: Missing Evaluation Dimension?	Q.3: Superfluous Evaluation Dimension?	Q.4: Missing Evaluation Criteria?	Q.5: Superfluous Evaluation Criteria?
Mode	4	5	5	5
Median	4	5	4	5
Average	3,2	4,3	3,5	3,8
St. deviation	1,4	1,4	1,6	1,6

Table 8.1 Some statistical figures for the answers to the four questions
(5= No, not at all; 1=Yes, indeed)

With the most picked answers (mode) to be three 5s and one 4, and with averages from 3,2 to 4,3, the above table shows that the participants leaned towards the opinion that there were no missing or superfluous Evaluation Dimensions or Evaluation Criteria.

Question 6 was asked in an effort to combine several metrics for one process into one overall metric. The 6 suggested metrics for Risk Identification were hoped to be an example of combining the many metrics into one overall metric. This part of the research was later taken out, in order to focus the dissertation on it's core research. The answers to question 6 is therefore not presented and discussed.

Question 7 ask the participant to:

rank each of the 6 suggested metrics on a scale from 1 to 5, after your opinion on how good the metric is.

The scale was given as: "If very well: pick 5, if very bad: pick 1, if somewhat in between: pick the middle rang. Pick 0 (NA) if you for some reason feel it is too hard to evaluate or answer."

Figure 8.1 below shows some statistical figures for the answers to question 7.

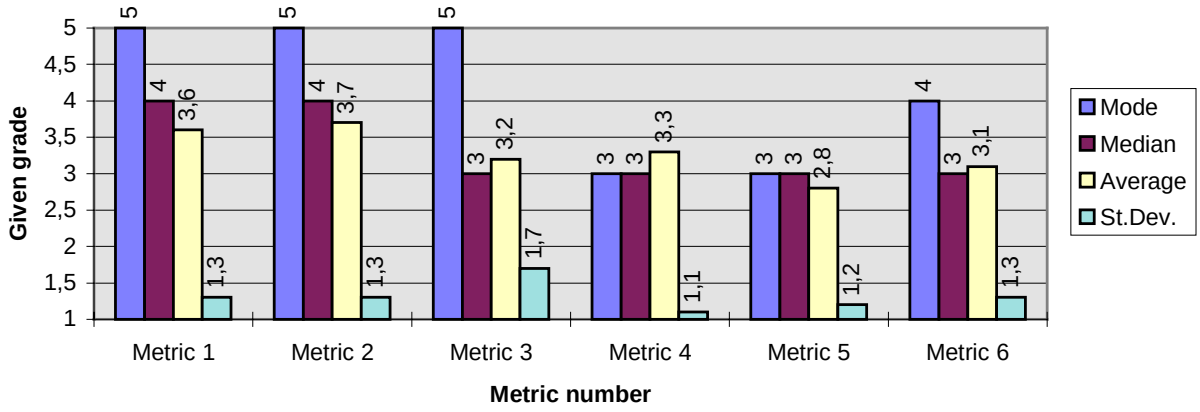


Figure 8.1 Some statistical figures for how good each of the 6 suggested metrics were according to the participants (5=very well; 1=very bad).

The most picked answer (mode) to all 3 first metrics were the top grade 5, "very well". *Metric 6* had 4 as mode, and *Metric 4* and *Metric 5* had 3 as mode. Ranked respectively after average grades, *Metric 2* (cost) and *Metric 1* (time), were perceived best. They were followed by *Metric 4* (quality), *Metric 3* (resources), *Metric 6* (quality), and *Metric 5* (quality). The respective average scores were from the highest 3,6 to the lowest 2,8, where the standard deviation varied from 1,1 to 1,7. These numbers show that some of the metrics were very well perceived, and the others quite well perceived. *Metric 5* with the lowest assigned grade (average 2,8) was perceived worst, but no metric seemed to be perceived bad. The participants lean clearly towards a positive opinion to the suggested metrics.

The two last questions were the following:

Question 8: Provided you are restricted to a critical few (4-8) metrics, can you think of any better metrics than the 6 suggested ones to measure the Risk Identification process on a project like your reference project?

Question 9: Provided you are restricted to a critical few (4-8) metrics, can you think of any better metrics than the 6 suggested ones to measure the Risk Identification process on projects in general?

Some statistical figures of the answers to the two latter questions are shown below in Figure 8.2 below.

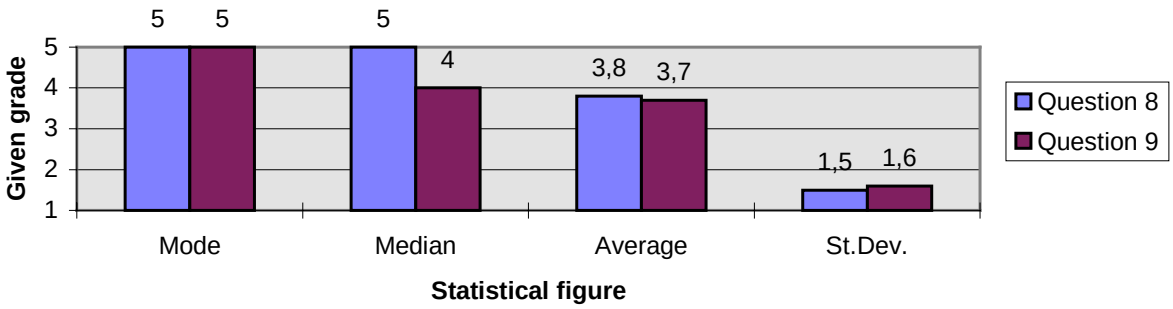


Figure 8.2 Statistical figures of the answer to question 8 and 9: (5= No, not at all; 1=Yes, indeed).

The average answers to question 8 and 9 are 3,8 and 3,7, respectively. The most frequent picked grade (mode) to both questions are 5. Thus, the participants lean strongly towards that they could not think of any better metrics either for a project like their reference project or for projects in general.

It was however surprising that the average answer to question 8 was a little higher than to question 9. This means that the participants overall found it slightly harder to think of better metrics to Risk identification for their reference projects than for projects in general. One would think the opposite should be the case, i.e. that it would be easier to think of better metrics to a reference project that you know the details in and thus should be able to define metrics. The numbers were not either expected to be so close. Question 8 was expected to get quite a lower average answer than question 9. This research have no explanation for these unexpected answers.

A cross analysis of the survey results by participants background and reference project was not done on survey part 2, when 20 respondents was considered to little for a through cross analysis.

8.3 DISCUSSIONS AND SOURCES OF ERROR

A thorough discussion of potential sources of error was done in chapter 5 with respect to survey part 1. Survey part 2 was a continuation of survey part 1, and will have the same categories of errors and for the most the same potential sources of error. The most significant difference between these survey parts, were that the total number of valid responses were 46 for the first part and 20 for the second part. A lower number of participants, i.e. a smaller sample, means that the sources of errors likely are higher. Both survey parts had a response rate around 45%. Please refer to chapter 5 for a further general discussion of sources of error.

However, survey part 2 evolved in a different way than survey part 1. After receiving and studying the first two respondent's answers to questions 2, 3, 4, and 5, it was clear that these questions were easily misunderstood. The questions were too conceptual to

be easily understood in the mail survey. Due to these first two respondents' misunderstandings, and taking advantage of a weekend and holiday, a letter with additional information and explanations was faxed to all remaining participants (See Appendix C). This was done to avoid and reduce misunderstandings with the remaining prospective participants. Even if the respondents who answered after the additional letter did not show the same misunderstandings as the first two with respect to these four questions, I am not certain that they all understood the questions thoroughly and in the same way. This could definitely be a source of error. It could also be that the survey participants felt the survey part 2 with the additional letter had an overload of information (see chapter 5 with this respect).

After this experience, it is my opinion that conceptual question like 2, 3, 4, and 5 are hard to grasp and may be understood differently by different people. These questions in survey part 2 may have been better conducted through a direct interview than a mail survey. The participants may in a direct interview ask questions, and many misunderstandings could have been avoided.

Consequently, the results from question 2, 3, 4, and 5, are questionable and could contain a high level of errors. Thus, this part should not be given a high emphasis. However, the questions 2, 3, 4, and 5, were only directed to the way the research was done to get to the metrics. The questions could have been left out of the survey, and should not influence the questions and answers to the developed metrics themselves. Even if the questionnaire for survey part 2 was tested before it was sent out, it was not tested as thoroughly as survey part 1. The lesson learned was that some of the above trouble or errors could have been detected earlier by a more thorough testing.

The questions on metrics did not have the same conceptual character. Thus, the information on the metrics themselves should not be so easily misunderstood. The feedback on the metrics should therefore have a similar validity as the findings to survey part 1, except for the lower survey population. The feedback on the metrics were also the most important result of the survey part 2.

8.4 CONCLUSIONS

The findings from the first questions about the evaluation criteria and evaluation dimensions, should not be given a too high emphasis when these questions were conceptual and may have been hard to grasp for the participants (see section 8.3).

The 6 metrics to the Risk Identification process presented in survey part 2, were perceived quite well by the participants. Metric 2 (cost) and metric 1 (time) respectively, were best perceived. These two metrics, and metric 3 (resources) are not metrics only for the Risk Identification process, but general metrics for all project management processes. Metric 3 was not perceived as good as the two first metrics, but was perceived okay (see Figure 8.1). Assuming that Risk Identification is a

representative process of all PMI project management processes, the good feedback on metric 1 and 2, and the okay feedback on metric 3, can thus be seen as a feedback for these 3 metrics for all PMI processes. All the three quality metrics, metric 4, 5, and 6, were also perceived okay (see Figure 8.1).

When asked, the participants leaned towards that they could not think of any better metrics for the Risk Identification process on a project like their reference project or on projects in general.

In sum, the participants leaned clearly towards a positive opinion to the suggested metrics.

PART 3. BENCHMARKING PROCESS MODELS

9. POTENTIALS, PROBLEMS, AND EVALUATION CRITERIA TO BENCHMARKING PROCESS MODELS

This chapter introduces the concept benchmarking process models and states the research focus and research steps for this part of the dissertation. The chapter discusses next anticipated potentials and problems for benchmarking in the project environment and for benchmarking of project management processes. Further are existing research on evaluation of benchmarking process models discussed, before evaluation criteria are developed for benchmarking process models fit for benchmarking of project management processes.

9.1 INTRODUCTION TO BENCHMARKING PROCESS MODELS

What is a benchmarking process model?

The benchmarking process can be divided into several steps, which describes the main activities that have to be done in a benchmarking study (Jakobsen, 1993a). These steps are often figuratively illustrated. The definition this research will use for a benchmarking process model is stated below (Andersen, 1995):

> ***A benchmarking process model is a graphic representation that describes the activities and their sequence necessary to conduct a benchmarking study.***

Example of a benchmarking process model:

Companies that do benchmarking, have often defined their own way to do benchmarking. Andersen (1995) listed sixty-four benchmarking process models encountered during his dissertation study. In section 9.2, this study adds a few more to Andersen's list, which would have totaled the two lists to 70 different models. There might exist even more models.

To illustrate a benchmarking process, the Xerox benchmarking process model is presented below in Figure 9.1. When Camp (1989) presented the model developed by Xerox, it was the first benchmarking process model to be officially published (Andersen, 1995).

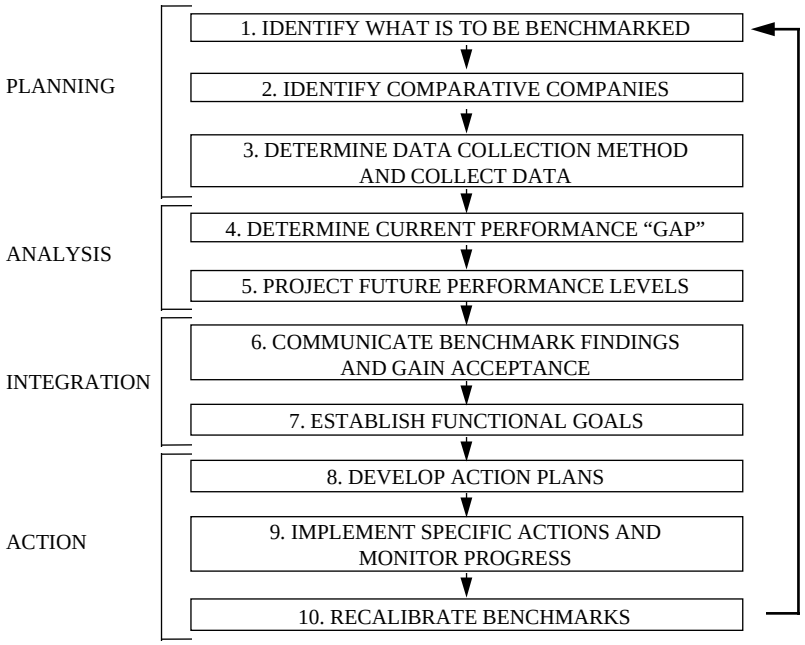


Figure 9.1 The Xerox benchmarking process model (Camp, 1989)

Purpose or need for a Benchmarking Process Model
Spendolini(1992) suggest that benchmarking process models have two basic needed characteristics: They provide structure and they provide a common language.

- By structure was meant that a benchmarking process model provides the basic framework for action. It describes a map of activities in a logical sequence that is necessary to complete a benchmarking study. Without the structure of a benchmarking process model, planning and execution of benchmarking investigations would have been more difficult.
- By common language was meant that the model provided a common language for the people involved in benchmarking, through familiarizing the employees with the terms and words used in the benchmarking process model. As an example, Spendolini mentioned the use of the term "phases" in the models. When involved people were informed that a benchmarking study was in a particular phase, they would know which activities that had been performed and which were to come.

Andersen (1995) states that benchmarking process models also provides a means for monitoring the progress of a benchmarking study and provides a more tangible framework around which benchmarking training can be structured.

9.2 FOCUS OF THIS RESEARCH

Purpose

The purpose of this part of the dissertation research was to address the fourth research problem described in chapter 3, section 3.1. The problem is summarized as: Evaluate existing benchmarking process models fitness for benchmarking of project management processes and, if necessary, suggest a new model that is targeted to fit for benchmarking of project management processes.

This part of the dissertation research will have an overview focus on benchmarking of project management and its processes, and will therefore include a more general discussion of anticipated problems and potentials for benchmarking of project management processes.

Research steps

The steps this research has followed is outlined below:

1. Potentials and possible problems of benchmarking in the project environment were discussed.
2. Evaluation criteria for benchmarking process models in the project environment were developed, based on existing evaluation criteria for benchmarking process models from the production environment and anticipated potentials and problems of benchmarking in the project environment.
3. Five existing benchmarking process models was textual evaluated after the developed evaluation criteria. These were found to not fit for benchmarking of project management processes (Research problem 4 partially addressed).
4. Using an existing benchmarking model as a basis, a new benchmarking process model was developed to fit project management processes by systematically changing the existing model's phases and steps.
5. Graphical representation of existing models were studied and the graphic illustration of the new model was developed through a creative session of combining existing types of graphics and trying new types. Thus, a new benchmarking model targeted to fit benchmarking of project management processes was developed (Research problem 4 addressed).
6. Existing benchmarking process models was numerically tested after the evaluation criteria, i.e. criteria that evaluated models' fitness for project management processes.
7. The new benchmarking process model was first textual evaluated, then followed by a numerical evaluation based on the evaluation criteria. The numerical evaluation was then used for finding the comparative strength of the new benchmarking process models to the studied existing ones.

9.3. ANTICIPATED POTENTIALS AND PROBLEMS FOR BENCHMARKING OF PROJECT MANAGEMENT PROCESSES

Since no studies directly targeting benchmarking of project management processes was encountered in this dissertation work, there are no exact experience to draw on to benchmarking of project management processes. Thus, the below described potentials and problems are a summary of my thoughts developed during this research work, as well as important points gathered from two sources: Readings on benchmarking and project management in general, and discussions with other people with an interest in the topic. The intentions of this section were not to cover all issues concerning benchmarking of project management processes, but rather point out the most important anticipated issues concerning potentials and possible problems related to such a benchmarking.

What are the potentials of benchmarking in the project environment: what can it help us with?

The total quality management (TQM) philosophy of continuos improvement is well encouraged in the production environment, and may have already entered the project environment. This philosophy is shortly described about creating strength and competitiveness for companies and organizations through quality awareness and continuously making small improvements in the performed practices and processes. Continuos improvement is illustrated in Figure 9.2, where the performance of practices and processes are illustrated improved with time through the up-right slope of the curve.

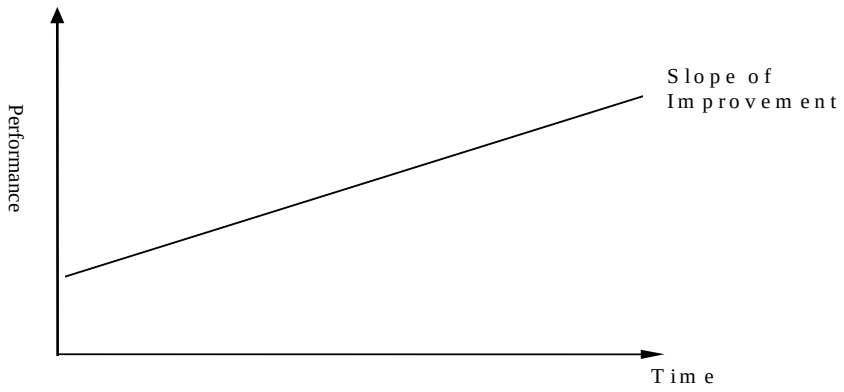


Figure 9.2 Illustration of continuos improvement

With the proper use of benchmarking, where one learn from others' practices and processes and implement improvements to own organization, the slope of improvement gets a considerate and immediate rise, as illustrated in Figure 9.3 below.

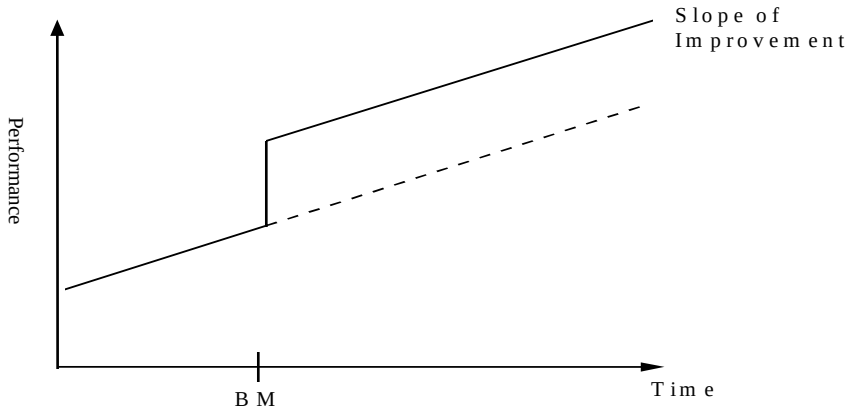


Figure 9.3 Illustration of improvement with benchmarking (Andersen, 1996)
("BM" in the figure is an abbreviation for benchmarking)

But what is really improvement of practices and processes? What is really to learn and improve? For project management and its processes, proper benchmarking can of course improve the way one handle the daily operations and managing of the project. The list of potential specific improvements are limited by imagination only. For a specific project management process, e.g. cost estimation, examples of improvement could be: better ways to structure and handle the cost database, i.e. cost data from previous projects; new or better ways to handle risk; improvement in the process that cost estimation follows until the product, i.e. the cost estimate, is done. In order to get a better perception of what benchmarking can help a company with and thus reach a fuller understanding of what the potentials of benchmarking are, there may be a need to structure the knowledge that can be gained from benchmarking in a more general way than described above.

In order to better be able to categorize the potentials of benchmarking, a somewhat philosophical view of what is to be learned from benchmarking is explained below and tried illustrated in Figure 9.4. The idea for this figure of what parts benchmarking can assist to improve, was gotten from a presentation on teamwork (Moravec, 1996). The thoughts and illustration was then initially created by myself, but modified after discussions with knowledgeable people in benchmarking, particularly Sterrer (1996).
This categorization could be for benchmarking in general, but the focus of this research is project management process benchmarking.

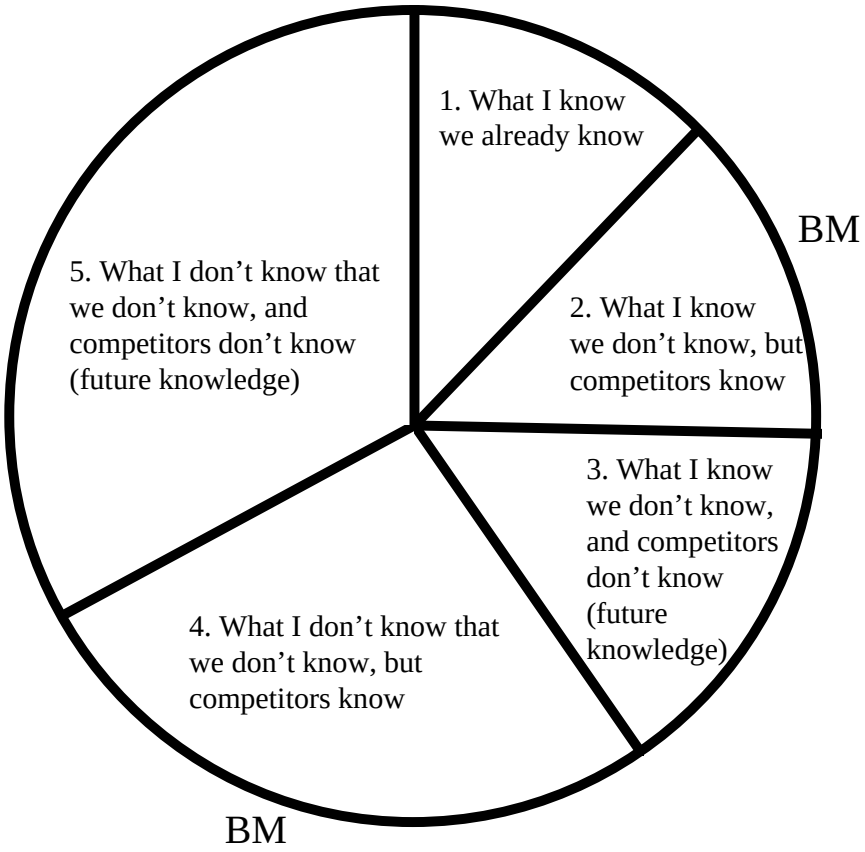


Figure 9.4 Areas of project management process knowledge needed for future success, related to areas where Benchmarking (BM) may directly assist.

In the strive for improvement, companies want to gain knowledge in areas that make them competitive and successful in the future. Related to project management processes, what areas of knowledge will or can benchmarking be concerned of? The pie chart figure above tries to illustrate the areas of project management process knowledge needed in the future, related to where benchmarking fits in.

Knowledge that is needed to be successful in the future, is divided into 5 pieces in the pie-chart. It could be divided further, but for a discussion on where benchmarking may assist, the 5 parts were considered appropriate. The 5 pie-chart pieces are described further below:

- Piece 1 is knowledge the company has and is aware of this knowledge. It is thus knowledge of today, i.e. present time.
- Piece 2 is knowledge the company does not have, whereas competitors have. It is thus also knowledge of today, i.e. competitors' present knowledge.
- Piece 3 is knowledge the company is aware of that they do not have, and know that competitors do not have either. If no present companies have this knowledge, it is thus knowledge that needs to be developed in the future.

- Piece 4 is knowledge the company is unaware of not knowing, whereas competitors know it. Thus, it is knowledge that exist today.
- Piece 5 is knowledge the company as well as competitors are not aware of not knowing at present time. It is knowledge that in time will be developed and needed for future success.

Benchmarking can only directly help with gaining knowledge in piece 2 and 4, marked with a "BM" in the figure. These are both knowledge areas where a company lack knowledge, whereas competitors have this knowledge. The difference of these two pieces is that in piece 2, the company is aware of not having this knowledge, whereas in piece 4, this knowledge would come as a surprise to the company during the benchmarking.

However, benchmarking should have the potential of affecting more than piece 2 and 4, because benchmarking may be used as the start of a thinking process and have spin-off effects into other pieces. Seeing competitors results and other ways of doing things than your own, might lead to the idea of yet another improved way. Thus, benchmarking will indirectly affect the future knowledge in piece 3 and 5 as well. The conclusion that can be drawn from this philosophical view on knowledge in project management processes, is that benchmarking seems to have high potentials to help making improvements in needed present and future knowledge areas.

Possible problems for benchmarking of project management processes

Several problems believed to be the most troublesome for benchmarking in the project environment are discussed below. The focus is at first the difference between production and projects. Later are some of the problems of benchmarking project management processes summarized.

Production versus projects

Benchmarking comes out of production environment which is different from project environment. Simply applying benchmarking process models in the new environment without studying the difference and adapting the model steps, would be the same as assuming that the environments of production and projects are the same. Can one really do that?

This dissertations author has problems with accepting this assumption. Projects are different from traditional production. The benchmarking process models from production are not made for projects and may not cover all the necessary steps and issues needed for a full guidance for benchmarking in the project environment. Therefore, existing benchmarking process models needs to be checked if they have the necessary coverage for the project environment. If not, should existing benchmarking process models be adjusted, and a new model should be made targeted to fit the new environment.

Projects are timely and organizational temporary:
According to Kerzner (1995), project management and product management are similar, with one major exception: the project manager focuses on the end date of his project, whereas the product manager is not willing to admit that his product line will never end. The product manager wants his product line to be as long-lived and profitable as possible. Even when the demand for the product diminishes, the product manager will always look for spin-offs to keep his product alive.

Said in different words: Projects are temporary. Production of one product is also temporary, but unlike projects that dismantle the whole organization at the its end, the production system change and start to produce other things, i.e. the production organizational system is more or less continuos. The project organizational system is discontinuous, i.e. temporary and limited by time, whereas production may go on continuously.

That projects are temporary, both organizational and timely, are believed to be the major difference between production and projects, and has implications to the conductance of benchmarking in the project environment. The temporarity makes the organizing of benchmarking efforts in the project environment more complicated than in the production environment. Organizational questions, probably harder to answer or determine in the project rather than production environment, include:

- What organizations involved in a project are to be involved in the benchmarking of project management processes? What are the problems (and advantages) of e.g. owners to include contractors in the benchmarking study?
- How are benchmarking information/data going to be stored - in what organization?
- How are improvement recommendations and implementation going to be done for all involved organizations? Should implementation be done jointly as one group or should it be done by each organization alone by themselves?
- Who is going to lead and be represented in the benchmarking team?

To illustrate the implications of these questions, 3 examples of different approaches of a benchmarking study of project management processes are briefly outlined:

1. Benchmarking of a single organization's project management processes.
Benchmarking of one organization's project management processes, e.g. Owner. This approach of conducting the benchmarking study is the most similar to benchmarking in the production environment, where often few organizations are involved from start. If the project is run with an active and heavily involved owner, this approach might work fine. However, the project management processes of the one organization, e.g. owner, may be so melted into the processes of the other organizations involved in the project, e.g. contractors and suppliers, that it is hard to separate what the owner do and can improve in the project management processes.

2. Benchmarking of the project organization, i.e. the project management processes of all parties/organizations that make up the project organization.
The project is a one-time event, and the organization is going to dissolve. A benchmarking of a project organization would then also be limited with time, i.e. often be a one-time event. The improvement recommendations found in a benchmarking study of this project's project management processes, must probably be adapted, stored and implemented by each individual organization involved. However, if the owner and contractor has an alliance, i.e. have an contractual agreement of being partners and are committed to mutually use each others services, the organization of the benchmarking will be a lot easier. The two organizations could be viewed as one, with only one storage of benchmarking data and one implementation effort of the recommended improvements found in the benchmarking study.

3. Benchmarking of a larger group of organizations, consisting of e.g. Owners and Contractors, for improving their project management processes.
A large group of organizations may do benchmarking of project management processes for collectively try to improve. This can be done by e.g. having a third party like a research or interest organization to take care of the benchmarking study, including collection, storage, and analysis of data, and further to draw up improvement recommendations for the participating organizations.

There are other differences between project management and production management than continuos or discontinuous organizations. Based on Westhagen (1994), Kerzner (1995), PMI(1996), Gareis(1995) and Cleland and Gareis(1994), examples of these differences that to a varying degree may cause problems for benchmarking are summarized in the following:

Projects are one time non-operational events
Projects are limited to one time events that differs from daily execution tasks in an organization, i.e. projects does non-operational tasks, whereas production often consists of an organization's daily or routine operations.

Projects are complex:
Projects are complex - socially and technically, and involves many parties(e.g. Owners, Consultants, and Contractors) and involves some inexperience with technology . Production may be a simple execution task, involving few parties, doing something technological known.

Projects are unique:
The project and its product is unique, i.e. the project and its output (product or service) is unique. One project have very different context, environment and/or geographic location from another project. A production and its product may not be unique, but may be repeated a number of times at the same location/environment.

Projects do not traditionally have a focus on processes:
There have traditionally not been a focus on processes in projects, whereas the production environment and TQM techniques like benchmarking focus on processes. Due to projects traditionally little focus on processes, the following fundamental problems of benchmarking in projects exist:

- Project management processes are not well defined within each organization or project. However, recent publications like the ISO Guidelines to Quality in Project Management (ISO 10006, 1996) and A Guide to the Project Management Body of Knowledge (PMI, 1996), are a major step forward in defining project management processes. As stated earlier however, companies need themselves to define their own project management processes for practical use.
- Measures and metrics for each organization's project management processes are not developed.
- Existing attempts in benchmarking in the project environment have had a tendency to "cover it all" rather than focusing on single processes. An example of this are the benchmarking studies of IMEC and Project 2000 (Andersen and Millar, 1996; Andersen, 1996; Millar 1996), where the scope of the benchmarking study was not targeted down to single processes.

Hard to decide on what to benchmark:
There is a problem even for benchmarking studies in the production environment to decide on "the right" process to benchmark. Compared to production, projects have little experience with Total Quality Management (TQM) concepts and techniques like continuos improvement and benchmarking, with their process focus. In addition, the processes that are repeated in projects tend to vary more compared to the more or less constant processes from production. These two factors combined, makes it harder for projects than production to identify processes with need for improvement. It is harder to define a process' importance and if it has a high or low performance.

9.4 DEVELOPMENT OF EVALUATION CRITERIA

In this section there will be developed criteria for evaluation of benchmarking process models' fitness for benchmarking of project management processes.

Past researchers requirements and criteria for evaluating and developing benchmarking process models in the production environment

The relevant existing work of two researchers in developing benchmarking process models in the production environment, were studied before evaluation criteria were developed for a benchmarking process model fit for benchmarking of project

management processes. Relevant points from their work are described and discussed below:

According to Spendolini (1992) there are 4 major requirements for a successful benchmarking process model. The model should:

1. *Follow a simple, logical sequence of activities.* Keep the process model as basic as possible and do not add steps for the sake of numerical superiority. The basic message her of Spendolini is about clarity of the process.
2. *Put a heavy emphasis on planning and organization*. Understand your own process and have a heavy emphasis on the planning and organizing activities, before any actual contact is made with a benchmarking partner. The types of activities Spendolini focus on in this part of the process is: a) a clear understanding of the benchmarking "customer requirements", where customer referring to the eventual user of the benchmarking information; b) procuring adequate resources, e.g. people, time, funding, to enable the benchmarking team to fulfill its mission.
3. *Use-customer focused benchmarking*. Benchmarking is a process that produces information as a product. Successful benchmarking organizations treat the benchmarking information product just as they would with any other type of product. The product must meet customer requirements if it is to be accepted and used. In this sense, every benchmarking product have a customer or a set of customers, and each customer have a set of requirements or expectations regarding the benchmarking information needed. A customer-focused benchmarking process places heavy emphasis on establishing contact with benchmarking customers, and on using some type of formal process to identify specific customer requirements regarding the benchmarking process, protocol, and information itself. In sum, Spendolini suggest to establish a set of customer requirements to the benchmarking product.
4. *Make it a generic process.* This means that the benchmarking process should be consistent within an organization. Although there should be some flexibility in the process to accommodate some level of variation, there is no need for a unique benchmarking process model for every department, division or location within an organization. Lots of models create problems, including: a movement away from a common organizational benchmarking language; different communication and training programs; confusion among the organization's benchmarking partners; and that multiple models of benchmarking usually indicate multiple benchmarking databases. The latter lead to a duplication of efforts, and a lack of coordination and comparability of data in databases.

The above 4 requirements by Spendolini, are all to a varying degree relevant to benchmarking process models in the project environment. Requirement 1 and 2 are just as important for a benchmarking process model in the project environment, due to their general nature and validity in both project and product environment. Thus, they will be brought forward in this research.

Requirement 3 about customer orientation is a good trait also for a benchmarking study of project management processes. However, this focus might be covered by other criteria going to be developed (like i.e. the criteria to meet the discussed problems of selecting the process and the criteria to develop metrics and measures such that the customer focus is ensured). The selection of a process and the definition of metrics should be two main elements of a benchmarking process model for project management process. Rather to have customer orientation as a criteria itself, it is viewed that the customer focus can be taken care of by these two main elements, and is therefore not brought forward as an evaluation criteria in this research.

A benchmarking process model that is generic/universal as stated in requirement 4, is a good trait of a model. However, it is not viewed important enough to be among the evaluation criteria brought forward by this study. That a model just can work for benchmarking of project management processes is more important.

Another important source of information in this dissertations attempt to develop a benchmarking process model fit for benchmarking in the project environment, is the previous mentioned dissertation of Andersen (1995). His research studied existing benchmarking process models and suggested a new model that could replace all benchmarking process models in production, i.e. a generic model for the production environment.

Andersen(1995) argue that the benchmarking process model is composited of two main elements:

- The process, i.e. the activities described by words. The main purpose of the process was to describe what steps should be carried out and in what sequence to conduct a benchmarking study. Anderson state this is the crucial element of the process model, as the quality of the resulting benchmarking study would be totally depending on it. If one essential activity was missing in the model, the benchmarking study would fail.
- The model, i.e. the graphics used. Andersen states that the main purpose of the graphics was to display the steps described and to enhance the user's understanding of the process. While not being as important as the process itself, the accompanying model served an important function in enhancing it.

"A *benchmarking process* could thus appear on its own, not accompanied by a *model.* In fact, quite a few processes were published as pure textual outlines of the steps" (Andersen, 1995).

Andersen (1995) suggested further the following criteria for evaluation of benchmarking process models, based on his own work and past researcher like

Spendolini (1992) and Zairi and Leonard (1994). The criteria was divided into the process contents and the graphical model:

Criteria for the benchmarking process (from Andersen, 1995):

1. *Contain all necessary steps in a benchmarking study*. The benchmarking process must describe all activities necessary to perform a complete benchmarking study.
2. *Describe a logical sequence of activities*. Even if all necessary steps were present, they might appear in an awkward order. Thus, the steps prescribed must be arranged in a logical order.
3. *Link the benchmarking study to strategy*. Benchmarking must be tied to the organization's strategy and other improvement efforts. An important property of the benchmarking process was thus to prescribe steps that would assure this link.
4. *Focus on business processes*. Benchmarking should have a strong focus on business processes and practices, because process benchmarking give better results than performance benchmarking.
5. *Emphasize planning*. Planning the benchmarking study, including mapping own process and composing the benchmarking team, is important elements.
6. *Emphasize improvement*. If the potential of benchmarking was to be fully utilized, the findings from benchmarking partners must lead to action. A good benchmarking process would thus include steps that described the implementation of improvements.
7. *Be generic and flexible*. The ultimate purpose of Andersen's work was to design a generic process model, and he therefore sought characteristics of a generic benchmarking process model. Activities or language specific for a particular organization should not be included in the process, and it should be sufficiently flexible to be used in many different organizations.
8. *Be easy to understand and use*. Andersen stated that benchmarking teams usually are composed of people with varying skills and education. A benchmarking process should thus be simple enough to allow ease of understanding and use. Several aspects could influence this criterion. For example, too many steps in the process could make it difficult to understand or apply, technical or highly advanced language likewise.

Criteria for the graphical model (from Andersen, 1995):

1. *The model must be able to emphasize key issues of the process*. Not only the individual aspects of the process and the model had an impact on the goodness of the process model. Also, the match between these two elements was important, and thus included in the criteria.
2. *Communicate the continuos nature of benchmarking.* Andersen states that benchmarking should be a continuos effort wherein benchmarks were recycled and new areas benchmarked. The model should therefore be able to convey this continuos nature of benchmarking.

3. *Be easy to understand and memorize.* As for the process, the graphical model should also contribute to the process model's ease of understanding and use. The graphic selected to represent a particular process could increase or decrease this ability. Being able to memorize the process would enable benchmarking team members to maintain an overview of the process without having to look it up.
4. *Be aesthetic and appealing in visual appearance*. To increase its user-friendliness and comfort of use, the model should simply put, look appealing. An aesthetic model would be more likely to attract attention and being used than a model being unattractive to look at.

Most of the above evaluation criteria by Andersen make sense also for a benchmarking process model in the project environment. The division of evaluation criteria into the two elements of a benchmarking process model, the benchmarking process and the graphical model, makes sense and were also done by this research. In fact, much of the criteria developed by Andersen was used. However, while Andersen considered process in production, this research considered processes in project management. The difference in focus, had to make a shift of focus of the criteria. Using Andersen's criteria as a basis, evaluation criteria for a benchmarking process model fit for project management processes was developed by deleting superfluous ones, changing the focus on some, and adding some missing ones. The specific criteria developed by Andersen, and its validity for the project environment is discussed in the following.

Adjusting the criteria to fit as evaluation criteria for benchmarking process models fit for benchmarking of project management processes

The evaluation criteria developed by Andersen are discussed below in the context of adjusting them and developing evaluation criteria for benchmarking process models that would fit for a benchmarking study of project management processes.

Criteria 2 for the graphical model: *Communicate the continuos nature of benchmarking* did not match the view of this research. For the production environment, benchmarking may be of a continuos nature, but in the project environment, it is not. For project management it is rather the improvement effort that should be continuos, i.e. always strive to be better in doing the project management processes. Benchmarking is one way to now and then enhance this improvement, but benchmarking in the project environment is not likely to be a continuos ongoing effort. Benchmarking is rather an event that is executed with varying frequency, and the graphic model should illustrate it as a temporary event rather than continuos.

Criteria 4 of the process: *Focus on business processes* needed a slight adjustment. As for the production environment, previous discussions argue for a process focus in benchmarking of project management as well. However, the term business processes is not proper in this research's context, and the term is replaced by project management processes.

Criteria 3 for the benchmarking process: *Link the benchmarking study to strategy*, is a criteria that may be harder to apply within the project environment. That benchmarking must be tied to the organization's strategy and other improvement efforts, is an very important issue. If a benchmarking study is conducted with focus on one organizations project management processes, to bring this issue in as part of the benchmarking process model seems proper. However, when many organizations are involved with varying strategies and improvement efforts, the strategy issue might split rather than unite the benchmarking team. It is important that the members of the benchmarking team know about each organization's objective of the benchmarking study. However, this research is not certain that the strategy issue should be a part of the benchmarking process model. This research did therefore not include the strategy issue as part of the evaluation criteria.

Criteria 7: *Be generic and flexible*. The ultimate purpose of Andersen's research was to create a generic model. The ultimate purpose of this part of this dissertation research was to evaluate if the models were fit for benchmarking of project management at a process level. A generic model is of course of interest of this research, but it does not have such a high priority that it will be among the evaluation criteria. That the model should be flexible enough to accommodate some level of variation, is however so important trait that it should be included in an evaluation. Still, it will not be an own criteria, but sought covered by other criteria, i.e. in Andersen's criteria 1 and partly 8.

Criteria 5: Emphasize planning, is of course important. However, the planning focus will be taken care of by other criteria that this research suggest. The criteria will not be brought forward the way it was stated by Andersen.

The other evaluation criteria by Andersen, are definitely needed for the model in project environment as well. However, due to their general nature, for e.g. process criteria 1: *Contain all necessary steps in a benchmarking study*, what this study consider to belong within each criteria is different from Andersen's view, while he looked at the production environment, not project management. The necessary steps for a benchmarking of project management processes are thus different from the necessary steps of benchmarking in production. The next pages will addressed this difference further. Other of Andersen's criteria would have a similar shift of content, e.g. process criteria 2: *Describe a logical sequence of activities*. This research's evaluation exercise of existing benchmarking process model will probably enhance a different logical sequence of activities from Andersen's evaluation.

With this research's focus on benchmarking process models' fitness for studies of project management processes, Andersen's criteria lack some issues previously discussed. These lacking issues are stated as additional criteria below:

- ***Focus on defining the organizational platform of the benchmarking study (and give guidance to address the organizational complexity/problems)***.
  The complicated organizational structure of a project or project management, is

brought into the benchmarking study as well. As mentioned earlier, if many organizations are involved in the same benchmarking study, careful considerations must be made in e.g.: selecting benchmarking team members; defining the need/interests of each organization involved in the study; agreeing on how to store data; as well as handle improvement recommendations and implementations. The benchmarking process should give guidance and focus on addressing this organizational issue.

- ***Emphasize to get an overview of the involved organizations' project management processes and practices, before deciding on one process for the benchmarking study.*** As mentioned earlier, deciding on the right thing (right process) to benchmark is hard in the production environment, and even harder in projects. Projects have little focus on processes and little experience in improvement techniques. In addition there are usually many organizations involved. It is important for the success of the benchmarking study, that each organization map and know their own project management processes, and are able to decide on which process they have an interest in improving. One way to decide on what process to improve have been illustrated earlier in this research. This was in Part 1, where the perception of each project management process' importance and performance have been mapped, thus making it possible to do a selection after improvement need. In a Statoil case study, Andersen and Pettersen (1996) inform that choosing the process was based on two main concerns: 1) The process must have an impact on customer satisfaction (external or internal customers); 2) The process must display a potential for improvement and cost reduction. With a sound knowledge of own processes, the organizations can decide on which process they jointly should pursue to improve.

- ***Emphasize the development of metrics and measures.*** Developing and defining metrics and measures have been mentioned earlier to be a major obstacle for benchmarking of project management processes. Consequently, to have proper metrics and measures are important for the success of the benchmarking, and should be included as a point in the evaluation of benchmarking process models.

The final adjusted criteria for evaluation of benchmarking process models fitness for a benchmarking study of project management processes, are listed in the next chapter where they are used to evaluate existing benchmarking process models.

10. EVALUATION OF EXISTING BENCHMARKING PROCESS MODELS

This chapter presents the developed evaluation criteria for benchmarking process models' fitness for benchmarking of project management processes. Five existing benchmarking process models will be selected among fifteen studied, and evaluated by textual assessment. The evaluation establishes a need for a new benchmarking process model targeted to fit benchmarking of project management processes. The chapter ends with recommendations for the development of such a new model.

10.1 THE DEVELOPED EVALUATION CRITERIA

The previous chapter developed evaluation criteria for a benchmarking process model fit for benchmarking of project management processes. The development was based on the discussion of problems to benchmark project management processes and the discussion of past researcher's criteria for evaluating benchmarking process models. These evaluation criteria are summarized below:

Criteria for the benchmarking process:

1. ***Contain all necessary steps in a benchmarking study***. The benchmarking process must describe all activities necessary to perform a complete benchmarking study of project management processes. The necessary steps should be flexible enough to accommodate some level of varying environment.
2. ***Describe a logical sequence of activities***. Even if all necessary steps were present, they might appear in an awkward order. Thus, the steps prescribed must be arranged in a logical order.
3. ***Focus on defining the organizational platform of the benchmarking study (and give guidance to address the organizational complexity/problems).*** The benchmarking process should give guidance in the organizational difficulties. The difficulties include: the selection of organizations to be involved; selection of benchmarking team members; handling of data storage; as well as handling of improvement recommendations and implementation.
4. ***Focus on processes***. Benchmarking should have a strong focus on project management processes and practices, because process benchmarking give better results than performance benchmarking. In addition, as discussed in the early section of this dissertation, the process focus enables benchmarking to target project management in it's purest form, rather than mixing heavily into the product-oriented part of the project.
5. ***Emphasize to get an overview of the involved organizations' project management processes and practices, before deciding on one process for the benchmarking study.*** The problem of deciding what to benchmark has several times been

discussed in this dissertation. It is important for the success of the benchmarking study, that each organization map and know their own project management processes, and are able to decide on which process they have an interest in improving. Thus, with a sound knowledge of own processes, the organizations can decide on which process they jointly (and separately) should pursue to improve.

6. ***Emphasize the definition of metrics and measures***. Defining metrics and measures have been mentioned earlier to be a major obstacle for benchmarking of project management processes. Consequently, to have proper metrics and measures are important for the success of the benchmarking, and should be included as a point in the benchmarking process model.
7. ***Emphasize improvement***. As mentioned earlier, improvement focus is needed to utilize the potential of benchmarking to it's full extent. The findings from the benchmarking study must lead to action. A good benchmarking process would thus include steps that direct to implement of improvements.
8. ***Be easy to understand and use***. Andersen (1995) pointed out that benchmarking teams usually are composed of people with varying skills and education. A benchmarking process should thus be simple enough to allow ease of understanding and use. Several aspects could influence this criterion. For example, too many steps in the process could make it difficult to understand or apply. Similar difficulties could originate from technical or highly advanced language. In order to be easy to understand and use, the model should also be flexible enough to accommodate for proper variation in the use of it.

Criteria for the graphical model:

1. ***The model must be able to emphasize key issues of the benchmarking process***. Not only the individual aspects of the benchmarking process and the graphical model had an impact on the goodness of the process model. Also, the match between these two elements was important, and thus included in the criteria.
2. ***Communicate the temporary nature benchmarking will have in the project environment*** . Benchmarking in the project environment will be a temporary effort that might be repeated, rather than an continuos effort as suggested by many researchers for the production environment. A benchmarking process model for project management processes should therefore not convey a continuous nature of benchmarking, but rather convey a temporary nature.
3. ***Be easy to understand and memorize***. Similarly to the textual part of the benchmarking process model, the graphical part should also contribute to the process model's ease of understanding and use. The graphic selected to represent a particular process could increase or decrease this ability. Being able to memorize the process would enable benchmarking team members to maintain an overview of the process without having to look it up.
4. ***Be aesthetic and appealing in visual appearance***. To increase its user-friendliness and comfort of use, the model should simply put, look appealing. An aesthetic

model would be more likely to attract attention and being used than a model being unattractive to look at.

10.2 DECIDING ON MODELS TO EVALUATE

The fourteen benchmarking process models that were studied during this research, are presented in Table 10.1 together with some of their characteristics. These characteristics are: number of phases, steps and sub-steps in the benchmarking process models, and a key word for their display or graphical representation.

Sources	Phases	Steps	Sub-steps	Representation
Andersen (Andersen, 1995)	5	8		Circular
Andersen and Pettersen (Andersen and Pettersen, 1995 and 1996)	5	5		Circular
Bendell et al (Bendell, Boulter and Kelly, 1993)		5		Text
Berggren (Teknologisk Institutt, 1992)		10		Text
Carey (Carey, 1995)		8	16	Text
Codling (Codling, 1995)	4	12		Circular
Gustavsson (Teknologisk Institutt, 1992)		5	18	Circular
Harrington (Harrington, 1991)	6	30		Flow chart
Harrington and Harrington (Harrington and Harrington, 1996)	5	20		Text
Leibfried and McNair (Leibfried and McNair, 1992)	5		19	Flow chart (arrows)
Spendolini (Spendolini, 1992)		5	17	Circular
Statoil (Andersen and Pettersen, 1996; Andersen, 1995)		6	25	Flow chart (arrows)
Thamhain (Thamhain, 1991)		6		Text
Xerox (Camp, 1989; altered slightly in Camp, 1995)	4	10	14	Flow chart

Table 10.1. Studied benchmarking process models and some of their characteristics.

All of these existing models were to some extent evaluated, but not as rigorously as the 5 selected below. There are even more existing benchmarking process models. Andersen (1995) encountered 64 different models, and Table 10.1 lists 6 additional

models to Andersen's registered ones including his own developed models, and thus total the number of different models on the two lists to 70.

The background for selecting five models for a closer evaluation was this. After glancing through existing benchmarking process models from the production and having a closer study on a few, like five, it was discovered that they were quite similar. Studying yet another model did not bring many new aspects for this analysis with its focus on benchmarking of project management processes. However, it was decided to initially study some higher number than five to ensure a good representative of existing models. Fourteen models were initially studied. The objective of this evaluation is not to evaluate all of them, but to evaluate a few selected ones that were believed to represent a cross section of them.

To determine which models that should be selected for further evaluation, the 14 models were grouped into classes of similar models (see Table 10.1). Various traits of the models could have been used as the basis for selection, e.g. little text versus verbose models, use of phases and steps versus only steps, graphic illustration versus no graphics, inclusion of certain activities or not, etc.

However, it was decided to select benchmarking process models based on the types of graphic representation/illustration, i.e. one from each of the following groups: textual, circular, flow chart, and arrow flow- chart. Further, it was decided to take models with varying number of steps. The rationale for these decisions was that the definition for a benchmarking process model emphasize on graphic representation and number of steps as two main elements. However, if a group had a model that distinguished themselves as often published, known, or generic/universal, it was decided to use it.

The 5 models selected for evaluation are listed below, with a statement of the characteristics that were determining their selection. A further explanation for why these were chosen is done together with the evaluation.

Models selected for evaluation

1. Textual model with 20 steps: Harrington and Harrington (1996)
2. Arrow (flow chart) model with 6 steps: Leibfried and McNair (1992).
3. Flow chart model with 10 steps: Xerox (Camp, 1989).
4. Circular model with 8 steps: Andersen (1995).
5. Textual model with 6 steps: Thamhain (1991).

The fifth model of this evaluation, by Thamhain, fall into another category, while it is the only encountered model to target project management directly. It was brought to my attention in January 1997, and was therefore not studied before a lot of this dissertation work was done. However, the evaluation will show that the model does not describe a complete benchmarking study.

10.3 EVALUATION OF FIVE BENCHMARKING PROCESS MODELS

Both numerical scores and textual assessments have been used by Zairi and Leonard (1994) and Andersen(1995) to compare benchmarking process models. However, their purpose was different from this research. The main purpose of this evaluation was not to assess the goodness of each model, nor to rank them. The main purpose was to evaluate the models fitness for benchmarking of project management processes and acquire knowledge in the evaluation exercise that may be used in the development of a new model targeted for benchmarking of project management processes. Therefore, this chapter uses textual assessment only in the evaluation. Later in this dissertation Part 3, an evaluation with use of numerical scores will be performed to compare existing models with a suggestion for a new benchmarking process model for project management process. These scores are shown in Chapter 12.

It is important to point out that it was the benchmarking process models themselves that were the objects for this evaluation. Consequently, supplementary or explanatory text provided in the publications were not considered. Last but not least, the evaluations were solely subjective expressions of my opinions and did not represent any absolute truths.

Evaluation of benchmarking process model by Harrington and Harrington

H. James Harrington has published two different benchmarking process models, both with great details, but one as flowchart and one in pure text format. The latter one in pure text format published in Harrington and Harrington (1996), was chosen for evaluation. The 4 studied models of pure text format developed for the production environment, varied in number of steps from 5 to 20 with average no. of steps equal 10,75. None of them displays any extreme features or widespread use, and a selection of one of the models could be done arbitrary. Due to the low or medium number of steps in the other models selected for evaluation, the reason for choosing this model was it’s high number of steps or what the Harrington and Harrington call activities. The number of activities are 20. Thus, the 5 selected models would have a good variety of number of steps and therefore represent models with different number of steps quite well. The model is shown in Table 10.2.

Benchmarking Phase	Related Activities
Phase I Planning the Benchmarking Process and Characterization of the Item(s)	1. Identify what to benchmark 2. Obtain top management support 3. Develop the measurement plan 4. Develop the data collection plan 5. Review the plans with location experts 6. Characterize the benchmark item
Phase II Internal Data Collection and Analysis	7. Collect and analyze internal published information 8. Select potential internal benchmarking sites 9. Collect internal original research information 10. Conduct interviews and surveys 11. Form an internal benchmarking committee 12. Conduct internal site visits
Phase III External Data Collection and Analysis	13. Collect external published information 14. Collect external original research information
Phase IV Improvement of the Item's Performance	15. Identify corrective actions 16. Develop an implementation plan 17. Gain top management approval of the future-state solution 18. Implement the future-state solution and measure its impact
Phase V Continuos Improvement	19. Maintain the benchmarking database 20. Implement continuos performance improvement

Table 10.2: Benchmarking process model by Harrington and Harrington.

An evaluation of this benchmarking process follows below:

Process criteria

1. Steps: Even though this process contained as many as 20 steps, important activities such as organizing the benchmarking study and team selection were missing. Between step 14 and 15, there seem to lack a step like analysis or establishing the reasons for the performance gap. The number of steps were so many that it got confusing, and the steps seemed to be addressed to a specific environment within production. In sum, the steps could not be used as they were and would need adjustments if they were to be used for benchmarking of project management processes.

2. Sequence: The activities that were present did not always follow a natural flow. Step 11 (Form an internal benchmarking committee) seemed to appear in an awkward order, since "team selection" was non-existent and not in the early steps. It is left in the open what personnel that are going to do the ten steps up to step 11. Another step that seem to be in an awkward order is step 6 (Characterize the benchmark item), that appears after step 3 (Develop the measurement plan). One should characterize or get to know the benchmarking item, before the metrics and measures are decided upon. The model would seem to follow a better flow, if step 6 was moved up before step 3. In sum, the criterion was not fully satisfied.
3. Organize: There were a focus on organizing the benchmarking study. Activities like forming a benchmarking committee and obtain management support were relevant. However, the organization issues should be addressed more specifically.
4. Processes: There were no focus on processes at all in this benchmarking process. The word process was non-existent. Thus, the criterion was not met.
5. Overview: The first step was: "Identify what to benchmark". It did not focus on getting an overview of what different items (or processes) that could be improved by a benchmarking study. The criterion was not met.
6. Metrics: The benchmarking process step 3 stated a need for developing a measurement plan, but it did not specifically state that metrics should be developed. The focus on developing metrics and measures could have been more direct. The criterion was partially met.
7. Improvement: The process did focus well on improvement and had focus on improvement action in several steps, i.e. as many as 5, thus ensuring this important part of a benchmarking study.
8. Understand: While 20 steps provided detailed instructions for the user, it seemed to bee too detailed to be user-friendly and allowing for making any personal adaptions of the benchmarking process. The number of steps itself could make it hard to memorize and keep track of the progress of the benchmarking study. However, the language was in general easy to understand, although it is not clear what the step 6 and the term "characterize" includes in this context.

Model criteria

1. Key issues: Since no graphics were used, this criterion did not apply to this model.
2. Temporary: The process states clearly a continuos nature of benchmarking, and not a temporary that is believed to be the nature of benchmarking in the project environment. Although in text form, the criterion was not met.
3. Understand: Since no graphics were used, this criterion did truly not apply to this model. However, the lack of a graphic illustration did clearly not add

any features that could help to understand or memorize the process better.

4. Aesthetic: A pure textual representation did not help to enhance the process itself. The appearance of such a model was not attractive, but rather plain, adding nothing to the appeal of the benchmarking process model.

Evaluation of benchmarking process model by Leibfried an McNair

Of the two models in the class of linear flow charts with arrow graphics, the model by Leibfried and McNair represented an extreme in terms of brevity. While the pure text model already evaluated was quite verbose with many steps, Leibfried and McNair's model contained only a few words altogether. Consequently, evaluating this model would provide advice for the opposite situation of having few steps.

The model is shown in Figure 10.1, with the evaluation of it below.

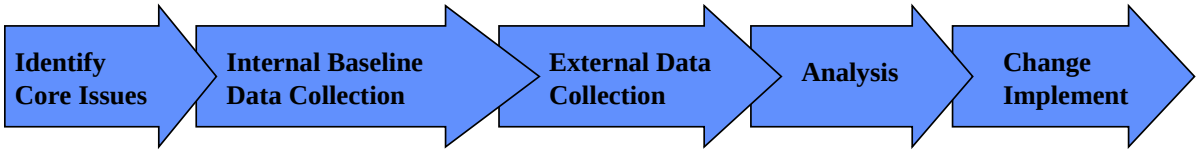


Figure 10.1 Process Model by Leibfried and McNair

Process criteria

1. Steps: Partly because of low number of steps and partly because of the extreme briefness of the steps in the benchmarking process, this model did not describe the steps necessary to perform a complete benchmarking study. The wording in these steps were very brief, and for the most did not define any specific activities.
2. Sequence: From my understanding of the activities described by these steps, they appeared to follow a logical order.
3. Organize: There benchmarking process had no mentioning of organizing the benchmarking study.
4. Processes: As for the first evaluated model, there were no mentioning of the term "processes" in this benchmarking process either.
5. Overview: This model also started directly on "identify core issues", giving no further guidance on this criteria that tries to help in addressing the problem of deciding on what project management process to benchmark.
6. Metrics: In step 2 and 3, the model covered the collection of internal and external data, and thus indirectly stated the need for developing metrics and measures. With the nature of the benchmarking process model, with such few steps and words in each step, the focus on this

criteria was considered better than expected. However, the focus was not specific enough to meet the criterion.

7. Improvement: Although the term ”improvement” was not used in the model, step 5 (change implement) meaning the same as improvement, gives an adequate coverage of this criterion.

8. Understand: The wording of the steps were too brief to provide any understanding of their contents. It would be very hard to carry out a complete benchmarking study based on this benchmarking process model.

Model criteria

1. Key issues: The arrow graphic of the flow chart helped emphasize that the steps belong to a sequence of activities that follow each other and form a process.

2. Temporary: There were no reference in text or graphics of a recycling of the benchmarking process, i.e. a continuos nature of benchmarking. On the contrary, the arrows indicate quite well that the process starts at one point and end at another, i.e. is of a temporary nature. Thus, the criterion is well met.

3. Understand: The uncomplicated and easy to understand graphics of this model helped well to define the sequence of the steps. Thus, the graphics served its purpose.

4. Aesthetic: The simple graphics of this model made it clear and clean, with no disturbing components. In my opinion, the graphics were aesthetic and appealing.

Evaluation of benchmarking process model by Xerox

Even though there are many good flowcharts models to choose from, to choose a model in this group was the easiest. The Xerox model is probably the best known benchmarking process model of all models existing today. This have to do with the pioneering work in benchmarking done by Xerox, and that this model was the first one to ever be published by Camp (1989). It could therefore not be left out of this evaluation, and it has already been described and shown in Figure 9.1. A slightly different model was published in Camp (1995), but this study evaluate the original model below:

Process criteria

1. Steps: Some important steps are missing in the ten detailed steps of this model. Andersen (1995) pointed out the lack of steps like documenting own process and determing the causes for the performance gap, in this model. For a use on project management processes, other missing steps are the ones assuring a good organization of the benchmarking study and team selection.

2. Sequence: The activities that were present in the process did follow a natural flow, with no steps appearing in an awkward order.

3. Organize: There were no mentioning of organizing the benchmarking study in the benchmarking process.
4. Processes: As for the first evaluated model, there were no mentioning of the term “processes” in this model either. Instead there were a rather strong focus on performance and numerical gaps, which are key issues for a performance benchmarking. The model therefore focus more on performance benchmarking at a high level, than process benchmarking at a process level.
5. Overview: This model also started with “identify what to benchmark”, leaving the problem of deciding on what to benchmark to the user. Since this problem exist both in production and project management, but especially the latter, getting an overview of the processes before selecting one, should be focused in such models.
6. Metrics: The model did not specify the need of developing metrics and measures for the item (process) to be benchmarked. Steps 3 (determine data collection method and collect data) indirectly shows a need for metrics and measures, but does not fully satisfy the criterion.
7. Improvement: Although the steps did not mention the term ”improvement”, the benchmarking process maintained a high focus on improvement and implementation of improvement actions. As much as four out of ten steps covered such activities.
8. Understand: Ten -10 -steps provided in clear text, detailed instructions for the user. While the number of steps seems necessary, the steps might be to detailed to allow any personal adaptions of the process.

Model criteria

1. Key issues: The graphic of the flow chart helped emphasize that the steps formed a process. Using lines to mark which steps that belonged to which phase clarified the model.
2. Temporary: Step 10 of the process instruct the user to recalibrate the benchmarks, indicating continuity. In addition, an arrow from step 10 to 1 instructed a recycling of the benchmarking process, so the model clearly encourage the continuos view of benchmarking. However, the flowchart do not give such a picture, but rather illustrates a temporary nature if without the arrow.
3. Understand: Ten steps may be close to the number of what is easy to memorize, but the grouping of steps into phases helped make this task easier.
4. Aesthetic: The graphics used immediately put the model ahead of the previous evaluated pure text model, and made the Xerox model look more appealing than the pure text model. However, such a traditional flow chart is split up too much, i.e. a box for each steps becomes visually too detailed. Boxes for phases instead of steps could be an idea.

Evaluation of Benchmarking process model by Andersen

Although there where other circular models that seemed good, e.g. by Spendolini(1992) and Codling(1995), it was decided to used a model by Andersen (1995). Of the 5 circular benchmarking process models, Andersen's model was the only with stated ambitions of being generic or universal, meaning they would replace all other existing models. Andersen have published two slightly different circular models. One of the models was published both in Norwegian (Andersen and Pettersen, 1995) and in English (Andersen and Pettersen, 1996). The other model was developed in his dissertation work (Andersen, 1995), which is the one that is shown in Figure 10.2. and is evaluated below the figure.

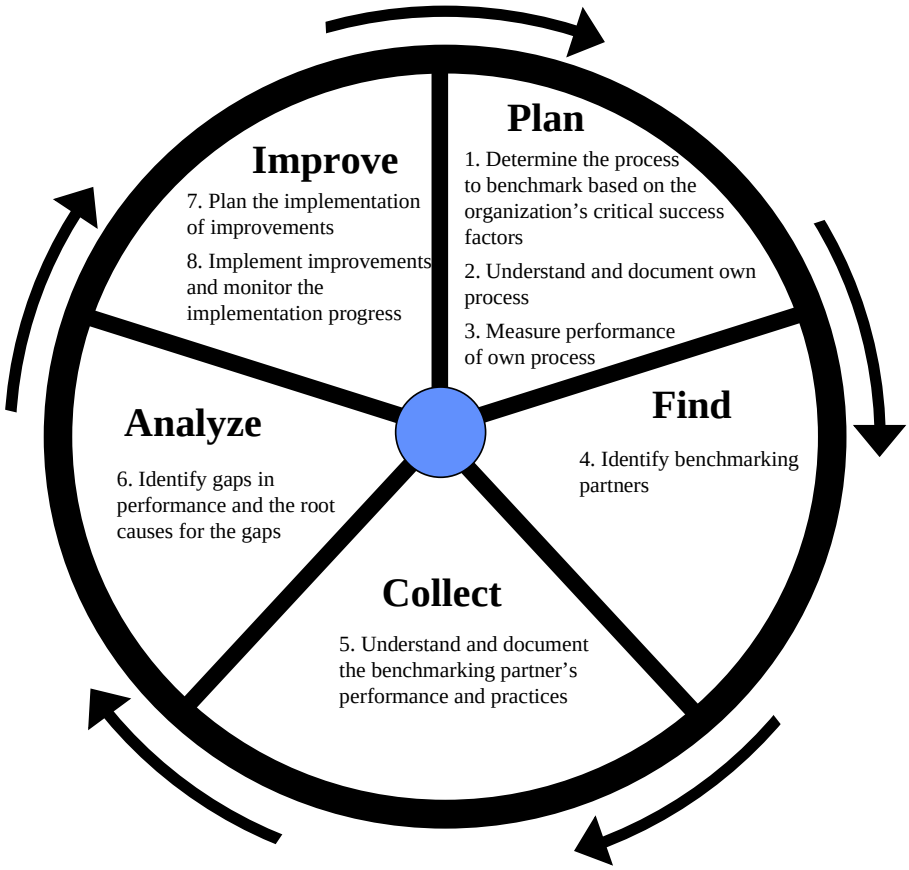


Figure 10.2. Benchmarking process model by Andersen (1995).

Process criteria

1. Steps: With as few as 8 steps, the relatively long worded steps of this model, gave good and clear instructions to direct a benchmarking study. However, important steps for benchmarking of project management processes like organizing the benchmarking study and the selection of a task team were missing. An "adapt" activity in or after the analysis phase also seemed missing. It is an important activity to adapt the analysis findings to recommendations for possible improvement within own organizations. However, it might

be viewed as indirectly stated in the second part of step 6 "Identify gaps in performance and the root causes for the gaps.

2. Sequence: The sequence of the activities described in the 8 steps, followed a sound and logical order. No steps seemed to be in an awkward order.
3. Organize: The benchmarking process had no mentioning of team selection or organizing the benchmarking study, and thus did not meet this criterion.
4. Processes: The process focus was well ensured, when as many as 5 of 8 steps used the word process.
5. Overview: This model went a good step further than the previous evaluated, by in step 1 stating the need to determine the process to benchmark based on the organization's critical success factors. Critical success factors may be one way to decide on what process to decide on for a benchmarking study of project management processes as well. However, as stated earlier, project management have not traditionally been process focused, and the lack of an overview of existing processes makes it harder to decide on process to choose for benchmarking there than in the production environment. The criterion of getting a full overview of all processes, do not have adequate focus in this model.
6. Metrics: Step 2 (understand and document own process) is the requirement for developing metrics and measures, and step 3 (measure performance of own process) instructs on the use of the developed metrics and measures. Although not specifically instructing to develop own metrics and measures, this model is so far best fulfilling this criterion.
7. Improvement: Improvement is emphasized well in the model. The term "improvement" was used several times, and this criterion was fully met.
8. Understand: The steps were long, but the instructions were clear and the words used in the step were easy to understand. The division of steps into 5 phases made sense, and the steps presumably became easier to understand. Despite the clear instructions, one term will be new to many people in project management, that is "critical success factors". Still, as one can see from the definition "factors of the business that are critical for success" (Andersen, 1995), it's meaning should be quickly grasped, but actually deciding on what the critical success factors are may be more difficult.

Model criteria

1. Key issues: The circle with the 8 steps inside, divided into distinctive pieces representing the phases, shows quite well the sequence of the activities into one process.
2. Temporary: The circle and the arrows illustrating a continuos movement, is of course made because the continuity is an important aspect of

benchmarking in the production environment. However, for project management processes the continuity of benchmarking is again not the case. The nature of benchmarking of project management processes is temporary, i.e. there is a direct conflict with this criterion.

3. Understand: Even if the graphic representation of the model consist of many parts, the model is uncomplicated and easy to understand. It is not hard to understand and memorize this model and its steps. To divide the steps into 5 phases separated by thick lines, helped to make the model even clearer. Thus, the graphics served its purpose.

4. Aesthetic: The resemblance to a wheel, that also gave the model a name, "The Benchmarking Wheel", is clearly a plus and makes it clean to look at. In my opinion, the graphics were aesthetic and appealing.

Evaluation of benchmarking process model by Thamhain

As stated earlier the model by Thamhain (1991), this pure textual model fall into another category, while it is the only encountered model to target project management directly. It was brought to my attention in January 1997, and was therefore not studied before much of this dissertation work was done. However, this dissertation work have eventually studied and evaluated this model equally to the others. The findings from this evaluation was incorporated into the existing work, and the model is thus considered just as much as the other models. Table 10.3 shows the six steps of the benchmarking process model. The evaluation is shown below the table.

Thamhain
STEP 1: Identify and Organize a Task Team
STEP 2: Breakdown the Project Management System
STEP 3: Prioritize and select Sub-Categories
STEP 4: Identify what to Benchmark
STEP 5: Develop the Metrics for the benchmarks
STEP 6: Identify the Best Practices for Comparison

Table 10.3 Benchmarking process model by Thamhain

Process criteria

1. Steps: The model contains certainly steps that were different from the other models. Further, the steps were more adjusted to the benchmarking of project management, like e.g. step 2 that target the overview of the project management system and step 5 that clearly instruct to develop metrics. However, some important steps are missing for this model, too. Step 6 instructs for identifying best practices for comparison, but the model lacks further steps, including steps for the collection of data and actual comparison and analysis of the data. The model did not either have steps to satisfactory take care of the important

improvement aspect. Thus, the model was not having the necessary steps for a complete benchmarking study.

2. Sequence: The activities that were present in the benchmarking process was arranged in a logical order, with no steps appearing in an awkward order.
3. Organize: The model did not contain a step for deciding on organizations to participate in the benchmarking study, but it included instruction to identify and organize a task team. Of the evaluated benchmarking process models, the organization issues were thus covered best in this model.
4. Processes: Although the steps instructed to select "sub-categories" of presumably project management, there were no mentioning of the term "processes" in this model.
5. Overview: The steps 2 and 3 were understood as very close to this criterion of getting an overview of the project management processes, before selecting one process for benchmarking. Thus, the criterion was quite well met.
6. Metrics: The model did specify the need of developing metrics, and met this criterion of developing metrics and measures.
7. Improvement: There were no mentioning of the term "improvement" or similar terms. The model did not include this important criterion.
8. Understand: The instructions in the models were clear and easy to understand. However, the term "Sub-categories" in step 3, might cause a problems to users.

Model criteria

1. Key issues: Since no graphics were used, this criterion did not apply to this model.
2. Temporary: There were no elements trying to indicate a continuos or temporary nature of benchmarking.
3. Understand: Since there were no graphics, these criteria did not truly apply. However, a lack of graphics did obviously not contribute to users understanding or memorization of the model.
4. Aesthetic: Pure text did not enhance the process itself. The capital letters of "step" may have been chosen to improve the appearance. However, the appearance of such a text model was rather plain and unappealing, adding nothing to the benchmarking process.

Evaluation Conclusion

None of the 5 above evaluated benchmarking process models had instructions that could guide users through a complete benchmarking study of project management processes. The evaluation exercise of the 5 models most importantly led to an increased knowledge about what constituted strong and weak sides of such models.

This knowledge was in turn applied during the design of a new benchmarking process model fit for project management processes.

10.4 IDENTIFIED FINDINGS AND RECOMMENDATIONS

So what was learned during the evaluation exercise that can help in the development of a new benchmarking process model targeted to fit for benchmarking of project management processes? The findings outlined throughout the exercise in the last chapter are summarized below. These findings or recommendations were used during the process of designing a new benchmarking process model focused on project management processes. For clarity, the findings and recommendations have been grouped and listed under headings indicating the dealt with topic and evaluation criteria.

General recommendations for phases and steps (process criteria 1, 2, 8 and model criteria 3)

- The studied models had from 5 to 20 steps. There seems to be a conflict of interest in that too few steps or too little information did not give enough guidance to perform a complete benchmarking study, while too many steps could make the process confusing and little flexible. There have to be a balance between these two interests. Five steps were clearly to few and 20 clearly to many. Somewhere between 10 to 14 steps seems necessary for a new benchmarking process model for project management processes, and is my recommendation.
- Grouping the steps into phases seemed to help for the clarity, and also for understanding and appeal. Thus, the use of phases are recommended. The number of phases are not so important, other than being fewer than the number of steps. Short worded phases that group the steps in a clear manner, seems to be more important.
- Due to the number of steps that seems to be necessary (see above), the need of users to memorize the steps should be toned down in the criterion 3 for the graphical model. However, the phases and the graphical model should be easy to memorize.
- There was an example of awkward sequence of the steps in one of the evaluated models that made it more confusing than necessary. It may be that the thoughts behind the steps actually were in a logical sequence, but that putting these thoughts into wording for a few steps made it look like an awkward sequence. The steps in a new model should thus strive for clearness in wording and sequence with respect to a logical order of the activities.

Recommended focus of contents for a new benchmarking process model targeted for project management processes (process criteria 3, 4, 5, 6, 7)

Findings from the evaluation exercise and earlier discussions with respect to contents for a new benchmarking process model targeted to fit for benchmarking of project management processes, are summarized and somewhat brought further in the discussion below. The contents of such a new model will also be discussed in the next chapters' sections while developing the steps and phases for a new model.

- **Organize**: The organizing criterion was not adequately focused on in the evaluated models from production environment. This criterion alone could thus make them improper to use in the project environment when many organizations are involved. Thamhain's model from project management had one step concerning this criterion, "identify and organize a task team". However, it is recommended that a new model for project management processes start a little earlier with deciding on the benchmarking study's organizational platform, i.e. deciding on what organizations that should be involved.
- **Process**: Of the four evaluated models from production environment, it was only one that directly used the term "process". This was surprising, knowing the production environments focus on processes. To look closer at this finding, the fourteen models from production environment (Table 10.1) was rechecked with respect to the process focus. Only 3 out of the 14 models had directly used the term "process" in the model, including the slightly changed Xerox model(Camp, 1995). However, when describing the step of identifying what is to be benchmarked, most of them (from what I could tell at least 12) focus on the advantage of selecting key business processes for benchmarking, rather benchmarking of performance. Why the term "process" is not used in the models, is believed to be because the designers wants to leave open the opportunity to use their models for performance benchmarking. It is possible for a new benchmarking model to be designed to target project management, rather than project management processes. However, the advantages of process benchmarking and earlier discussion conclude that the processes is where one find project management in it's purest form and where one can learn from project to project. Thus, the focus on project management processes is still recommended for a new benchmarking process model.
- **Overview**: The 4 production environment models did not focus on getting an overview of the business items/processes, before deciding on one item/process to benchmark. Thamhain's model for benchmarking in project management did so. In order to guide in the problem of deciding on what process to benchmark, it is recommended that this criterion is in focus when developing of a new model for project management processes, too.
- **Metrics**: No production environment models did specifically instruct to develop metrics and measures. Thamhain's model for benchmarking in project management did so. Due to the problem of developing metrics and measures, this activity should be clearly spelled out in the new model.

- **Improvement**: Benchmarking must lead to action. All production environment models covered this important criteria, but with various strength. Thamhain's model for benchmarking in project management lacked this important criteria completely. A new model must ensure a strong focus on improvement action.

Language and terms

The choice of language and terms in the models influenced several aspects of the benchmarking process model, including its flexibility and ease of understanding.

The prospective benchmarking teams to benchmark project management processes, will consist of people with various background. Many or a majority of the team members will probably be people with project management background. For many of this people are words like e.g. "benchmarking", "metrics", and "process evaluation criteria", new and somewhat from another world. Some of these terms or conceptual issues frequently used in the production and total quality management environment, can not be avoided, but must be kept to a minimum in order to reduce the problems of understanding the phases and steps. That some of the words, and especially words of a conceptual character, were hard to grasp for project management personnel, was one of the lessons learned in the survey conducted in this dissertation research.

Similarly, technical words and terminology specific to an organization, like e.g. "sub-categories", "baseline", "external original research", and maybe "critical success factors", should be avoided or kept to a minimum.

The longer the steps and activities were described, the more specific they became. This length might endanger the flexibility of the model, i.e. reduce some users need of adjusting the steps to their own situation. In addition, longer wording of steps and phases are harder to memorize. On the other side, short wording or descriptions of the steps might be inexact and could lead to confusion. The steps being understood is of highest importance. Thus, a major finding learned from the evaluation exercise, was that a new model should prioritize understanding, rather than flexibility and memorable steps, although trying to balance the issue. The recommendations are consequently that long wording of some steps seem necessary to give clear instructions of needed activities in a new model.

The graphical representation (graphical model criterion 2, 1, 3 and 4)

The evaluation of existing benchmarking process models had revealed four main types of display or graphical representation, namely pure text, traditional flow charts, arrow flow charts, and circular models. The pure textual representation is not recommended, while it was found rather plain and added nothing to enhance the representation of the model. The discussion of the different types of models are done by each evaluation criteria below:

- **Temporary**: The immediate lesson learned by studying the different groups of graphical representation was that the circular models do not fit for benchmarking of project management process. Circular models are representing the believe of a continuos nature of benchmarking in the production environment, and thus conflicts with the believe of a temporary nature of benchmarking in the project environment. Flow chart representation in traditional or arrow form convey better the temporary nature, and are thus encouraged.
- **Key issue**: That the graphical representation of the model, in addition to its text, should emphasize key issues of the benchmarking of project management models seems harder to meet. The temporary nature mentioned above is one of them. Of other key issues, improvement is maybe the one that single out as most important, and should be emphasized in the graphical representation.
- **Understand**: This criteria was briefly touched upon earlier, but additional comments are given here. Having a simple graphical form like the arrows in Leibfried and McNair, should make the model clean and easy to understand. In addition, if the model could represent an easy recognizable item like e.g. the wheel in Andersen's model, that would be a strong advantage for both memorization and understanding. The traditional flow chart form as used in Xerox's model, is easy to understand, but not giving the model a graphical representation that is either simple or easy to memorize. The too many graphical objects that this model consist of might appear stretched out and may reduce its clarity.
- **Aesthetic**: Continuing the discussion of the above criterion, traditional flowcharts are just split up in to many parts, and do not seem to convey a graphical "whole" very well. The Xerox model do thus not have the same visual appeal as the circular model of Andersen or the arrows of Leibfried and McNair, a finding to remember when developing the new model's graphical representation.

During the evaluation exercise, many thoughts and ideas were formed. Some of these were quickly evident and expressible, as shown above. Others had probably a more subtle nature and were perhaps overlooked when the impressions were summarized and written. However, the evaluation exercise of benchmarking process models portrayed in this dissertation, combined with a knowledge of project management and its processes, provided me with a multitude of views on existing benchmarking process models and ideas for what a benchmarking process model for project management processes should consist of. These thoughts and ideas were valuable for the development of a new benchmarking process model, shown in the next chapter.

11. DEVELOPING A NEW BENCHMARKING PROCESS MODEL

This chapter shows the development work for a new benchmarking process model targeted to fit benchmarking of project management processes. The phases and steps for a new benchmarking process are first developed. Then, a graphical representation for the new benchmarking process is developed.

11.1 DEVELOPING PHASES AND STEPS FOR A NEW BENCHMARKING PROCESS

Strategy to develop phases and steps of a new benchmarking process

This research needed a starting point or basis as where to the phases and steps of a new benchmarking process model for project management processes could be developed. The most reasonable starting point was to use an existing model, and adapt the phases and steps until the phases and steps satisfactory covered what was needed to guide a complete benchmarking of project management processes. The adaption of the phases and steps had to be done by deleting superfluous ones, adding missing ones, and changing the ones that needed changes.

The model developed by Andersen (1995) shown in Figure 10.2 was decided to be the starting point. The reason for choosing this model is because its phases and steps were developed after a through study of 64 benchmarking process models, in an attempt to replace them all by making an universal or generic model for the production environment. Thus, this model should be one of the most general ones. In addition the model has a process focus. The evaluation exercise showed some missing focus and steps for this model to instruct a complete benchmarking study of project management processes, but of the models studied it was the one that probably would need least adjustment. The phases and steps of the model are shown in Table 11.1 below.

Phases	Steps
Plan	1. Determine the process to benchmark based on the organization's critical success factors
	2. Understand and document own process
	3. Measure performance of own process
Find	4. Identify benchmarking partners
Collect	5. Understand and document the benchmarking partners' performance and practice
Analyze	6. Identify gaps in performance and the root causes for the gaps
Improve	7. Plan the implementation of improvements
	8. Implement improvements and monitor implementation progress

Table 11.1. Phases and steps of Andersen's benchmarking process model

Determining the phases of a new benchmarking process model

To be fit for project management processes, the evaluation of Andersen's benchmarking process showed basically two missing parts that could be considered as phases. One of the missing parts was the process criterion 3, about focusing on defining the organizational platform of the benchmarking study, i.e. give guidance to address the complex organizational situation in the project environment. This added phase would need to be placed first and was called "Organize", thus keeping the instructional focus of the phase wording in Andersen's model. Other parts of this organizational criterion needs to be taken care of when the steps are adjusted.

The other part of the above benchmarking process that was missed and could be considered as a phase, is between the phase analyze and implement. The missing part is about adapting the findings from the study and was pointed out in the previous evaluation. By studying closely step 5, 6 and 7, it was evident that the model instruct to collect data from the partners, analyze them by identifying gaps in performance and the root causes of the gaps. However, it did not instruct to adapt the analysis findings to improvement recommendations that would fit the organizations concerned, before the implementation was to be planned. With the many organizations in the project environment, the focus on adapting the findings should be clearly spelled out. The phase that was added is called "Adapt" and would fit between the phases Analyze and Improve.

None of the existing phases were considered to be superfluous or in need of change during the evaluation or at this point in the model development.

Determination of steps to a new benchmarking process model

Adding missing steps

The two added phases were left without steps and were to have some developed for them. The organize phase was to ease the problems a benchmarking study gets due to the complex organizational structure in the project environment, by helping to create the organizational platform of the benchmarking study. The organization issue have been discussed earlier, and this research suggested two activities to create the necessary organizational platform. The first activity was to decide on the benchmarking study's initiating organizations. The second was to form a task team for the benchmarking study. The steps could be worded as follows:

- Decide on the benchmarking study's initiating organizations.
- Form a benchmarking task team.

The organize phase is about forming the organizational platform for the benchmarking study in an complex organizational situation of the project environment. An equally complicated part of the organizational issue, turns up after the analysis phase, when the findings are going to be adapted and implemented in the initiating organizations. The adapt phase is about adapting the findings from comparison and analysis to

recommendations for improvement that fit the individual organization that originally participated in the benchmarking study. The step could be worded as follows:

- Adapt findings and make recommendations for process improvement to organizations initiating the benchmarking study.

However, the adaption and improvement recommendations must lead to improvement action. Should the organizations involved implement improvements together or each separately? Due to the many possible organizational approaches to conduct a benchmarking study in the project environment previously discussed in chapter 8, this decision must be made by the conductors of each benchmarking study, e.g. the task team. This decision activity must be spelled out clearly in the benchmarking process, and could be worded as:

- Decide if improvement implementations should be done together or separately by the participating organizations.

The next activity the above benchmarking process should include is to address the previously discussed problem of "deciding what to benchmark". This research suggest to focus on this issue by adding an activity to get an overview of all your project management processes, before selecting one process to benchmark. It will thus be clear that some research needs to be done on own processes, before selecting one for improvement through benchmarking. The suggested activity could be stated like the following step:

- Understand and document all own project management processes, before selecting one process for benchmarking.

The last activity discussed missing in the evaluation of the above process model, and needed to be added, was the activity of developing metrics and measures. The need of this activity to be clearly spelled out have been discussed in the evaluation exercise and previous parts of the dissertation. The activity could be worded as the following step.

- Develop metrics and measures for the selected process

The adaption of Andersen's benchmarking process have up to now consisted of adding missing phases and steps. This initial adaption was called alteration 1, and the current phases and steps after the additions are shown in Table 11.2.

Phases	Steps
Organize	1. Decide on the benchmarking study's initiating organizations.
	2. Form a benchmarking task team.
Plan	3. Understand and document all own project management processes, before selecting one process for benchmarking
	4. Determine the process to benchmark based on the organization's critical success factors
	5. Understand and document own process
	6. Develop metrics and measures for the selected process
	7. Measure performance of own process
Find	8. Identify benchmarking partners
Collect	9. Understand and document the benchmarking partners' performance and practice
Analyze	10.Identify gaps in performance and the root causes for the gaps
Adapt	11.Adapt findings and make recommendations for process improvement to initiating organizations of the benchmarking study
Improve	12.Decide if improvement implementations should be done together or separately by the participating organizations.
	13.Plan the implementation of improvements
	14.Implement improvements and monitor implementation progress

Table 11.2. Phases and steps after alteration 1.

Taking away superfluous steps and streamlining the contents

Clearly, there are now overlap between some of the steps. The number of steps may also be a little to high. The next adaption work needs to take away the overlap and superfluous steps, and change other steps to streamline the contents of the benchmarking process. The only way that this research could think of doing this alteration 2, was by analyzing step by step, of the benchmarking process in the previous page's Table 11.2. The focus were on contents, rather than language and terms which were focused on later. Starting with the first step, alteration 2 is shown below:

- Step 1 seems to be a good starting point of a benchmarking study of project management processes. It is left like it is.
- Step 2, form a benchmarking task team seems to be the next logical activity in a benchmarking study. However, when you look from step 2 to step three, there seem to be something missing. Before one can go ahead and study/understand and document all own project management processes, some top management commitment and allocation of resources are needed. The top management commitment is indeed needed, but may not really represent and activity within the benchmarking study. However, the allocation of resources is an activity that reflect the top management commitment and directly affects the benchmarking study. Step 2 was therefore added the following: "... and allocate resources".

- Step 3 seems to contain the next natural activities. However, as previously discussed, project management have rarely defined what processes it consist of. To define all processes, is necessary before one can understand and document them. This define needed to be added to step 3. Looking at activity 4, shows a clear overlap with step 3, while both activities contain the instruction to select or determine the process to be benchmarked. Step 4 that is still in original wording from Andersen's model, contains also an instruction to do the process selection based on the organizations critical factors. As pointed out in the evaluation, this guidance for selection is indeed a good attribute. However, part 1 of the dissertation (chapter 5, section 5.4) describes ways of deciding on what project management process to benchmark, and there where two main elements recommended for the selection. The two main elements were to select the process based on improvement need, e.g. performance versus importance, and the perception of potential gain of improving the processes through benchmarking. The latter reflects that for some processes, there may be better ways of improving than through a benchmarking study. A decision on changing step 3 and 4 had thus to be made. It was decided to take out the activity of process selection and leave that for step 4. Step 3 would thus be worded as follows: "Define, understand and document all own project management processes".
- As for step 4 of the instructions that should guide potential users through a benchmarking study of project management processes, the above discussion concluded with a suggestion for new content. The new wording of this step was suggested to be: "Determine the project management process to benchmark, based on all processes' improvement needs and potential gains of a benchmarking study".
- Step 5 should be superfluous, while all process by now should have been understood and documented. Step 5 was therefore taken out.
- Step 6 seem to include the next natural activities. However, it is very close to the instruction in step 7, and both seems to be needed. Thus, the two steps may be combined to: "Develop metrics and measures, and measure performance of own process."
- Step 8 instructs only to identify benchmarking partners. Surely, there are more to this step and phase in a benchmarking study of project management processes, than just "identify". Potential partners, i.e. companies or projects, must be searched for, and some of them be prioritized and selected to be contacted. What criteria the priority is based on, must be decided by the task team. The next activity after a selection is made, should be contacting the potential partner, and if a positive response, agreeing upon the terms. However, it is not possible to describe all activities in detail of a benchmarking study, so a compromise between the existing short step and the elaborate activity description above must be made. Leaning towards the short description and borrowing words from the Xerox model, the suggestion for a new step 8 became: "Identify comparative companies and projects".
- Step 9 seems to be clear as the next logical step for a benchmarking study. There seemed to be no overlap with prior of subsequent steps. It was left unchanged.

- Step 10 instructs clear what seems to be the next necessary activities of the benchmarking study, with no identified overlap with other activities. It was also left unchanged.
- There might be an overlap between step 11 an 12, when they both focus on the specification or targeting of improvements. However, it could be that it is rather the sequence of the steps that cause this slight confusion. If step 12 was taken out of the improve phase and placed before step 11 in the adapt phase, it might cause confusion, too. Step 12 was suggested changed to the following and moved in front of step 11: "Decide if adaption and improvements should be done together or separately by the participating organizations". Other parts of step 11 and 12 is not altered.
- Step 13 seemed to be the next logical step. However, the steps wordings "plan the implementation of improvement", was very general. A try to specify the step without loosing the contents could be " establish a process change plan". Yet, the term "change" could be specified. "Improvement" describes maybe more correctly an alteration in the positive aspect than the term "change". Thus, the suggestion for a new wording of the step was: "Establish a process improvement plan".
- Step 14 have the next logical activities, and have no overlap with the prior step. Thus, it was not changed.

The wording of the phases and steps after the previous changes, i.e. alteration 2, are shown in Table 11.3.

Phases	Steps
Organize	1. Decide on the benchmarking study's initiating organizations.
	2. Form a benchmarking task team and allocate resources
Plan	3. Define, understand and document all own project management processes
	4. Determine the project management process to benchmark, based on all processes' improvement needs and potential gains of a benchmarking study
	5. Develop metrics and measures, and measure performance of own process
Find	6. Identify comparative companies and projects
Collect	7. Understand and document the benchmarking partners' performance and practice
Analyze	8. Identify gaps in performance and the root causes for the gaps
Adapt	9. Decide if adaption and improvements should be done together or separately by the participating organizations
	10. Adapt findings and make recommendations for process improvement to initiating organizations of the benchmarking study
Improve	11. Establish a process improvement plan
	12. Implement improvements and monitor implementation progress

Table 11.3. Phases and steps after alteration 2.

Modifying language and terms

Similarly as for the alteration 2 above, a third alteration to focus on understandable language and terms in the phases and steps, was to be done by going through them, one by one. Starting from beginning of Table 11.3, this alteration 3 is shown below:

- The phase organize seemed to be a good overview of the steps 1 and 2, and was left unchanged.
- In step 1, the terms "initiating organization" seemed to be too specific, but was believed necessary. If e.g. "participating" was used instead of "initiating", the organizations considered in this step might be confused with the benchmarking partners in step 6. Only the organizations that are initiating the benchmarking study were to be considered in this step, and thus the term "initiating" was left unchanged. However, the structure of the sentence was improved by bringing the important parts closer to the beginning. The suggestion for step 1, was thus: "Decide on initiating organizations in the benchmarking study".
- Step 2 seemed clear in language and terms and was left unchanged.
- Plan seemed to be the phase term to cover the activities of step 3, 4 and 5 quite well, and was thus unchanged.
- Step 3 seemed a little awkward with three command words "define, understand and document". The step might be understood as an instruction to mapping all processes in detail, and that was not intended. The important instruction of this step was to ensure that all processes are to be defined, prioritized, and considered for a benchmarking study, before one process finally is selected in step 4. The level of detailed information needed for each process before a selection is made, should be up to the users. The language used in this step should then maybe tone down the need to detailly study all processes, by taking out the term "document". Thus, the new wording of this step was: "Define and understand all own project management processes".
- Step 4 seemed a bit long and a little to specific, too. The wording instruct to specifically choose a process based on the two suggested ways of prioritizing, and that was not the intended meaning. There might be other ways to prioritize what process to benchmark, the two ways where just an example of how one could do it. To shorten this long step, the term "project management" was not needed to be repeated from the previous step, so it was taken out together with the last word "study". The suggestion for a new step 4 was thus: "Prioritize all processes and determine one to benchmark based on e.g. improvement needs and potential gain of benchmarking". The step might still be long, but no way was found to reduce the length further without loosing the content.
- Step 5 might seem a little confusing due to the double use of the term "measure", the former a noun and the latter a verb. The thesaurus (Random House, 1987) was checked to find another term to replace preferably the verb "measure", while the noun "measure" have often previously been used in conjunction with the term "metrics". The thesaurus suggestions for the verb included: ascertain the dimension of, find the size of, pace off, to be the size of, evaluate, value, assess, appraise, gauge, survey and judge. None of these suggestions seemed to replace the intended

meaning of the verb "measure". An appropriate replacement for the noun "measure" might have been found in the noun "measurement". However, due to the previously mentioned worked in use of the noun and that the step actually had a correct wording, no changes were made.

- Both the wording of the phase "Find" and step 6 seemed to be okay language wise, and no changes were made.
- Phase "Collect" was worded okay.
- Step 7 should maybe consider to use the same term as in step 6, i.e. "comparative companies and projects" instead of "benchmarking partner". To reduce the wording, "companies and projects" were changed to "organizations". Thus, the new suggestion for Step 7 was: "Understand and document the comparative organizations' performance and practice".
- The wording for the analyze phase and step, i.e. step 8, were considered okay and thus not changed.
- "Adapt" seemed correct for the following phase, and was thus not changed.
- Step 9 was not clear on what to adapt, and the sentence might be a little specific and awkward. The use of the term "participating organizations" was confusing as mentioned earlier, while it could include the "comparative organizations". It was therefore changed with "initiating organization". A new suggestion for step 9 was: "Decide on strategy for adapting findings and implementing improvements, e.g. all initiating organizations together or separately".
- Step 10 was okay. No changes.
- The word "Improve" seemed proper for the next phase, and thus no changes.
- The wording in step 11 seemed fine. No changes.
- The word "monitor" was considered replaced while it may indicate a continuos activity. However, in it's context, "monitor implementation progress", it seemed fine, and was thus not altered.

Table 11.4 shows the phases and steps, after the above changes.

Phases	Steps
Organize	1. Decide on initiating organizations in the benchmarking study
	2. Form a benchmarking task team and allocate resources
Plan	3. Define and understand all own project management processes
	4. Prioritize all processes and determine one to benchmark based on e.g. improvement needs and potential gain of benchmarking
	5. Develop metrics and measures, and measure performance of own process
Find	6. Identify comparative companies and projects
Collect	7. Understand and document the comparative organizations' performance and practice
Analyze	8. Identify gaps in performance and the root causes for the gaps
Adapt	9. Decide on strategy for adapting findings and implementing improvements, e.g. all initiating organizations together or separately
	10. Adapt findings and make recommendations for process improvement to initiating organizations of the benchmarking study
Improve	11. Establish a process improvement plan
	12. Implement improvements and monitor implementation progress

Table 11.4 Phases and steps after alteration 3.

Checking steps and language yet another time

Studying the steps and wording after alteration 3, there were still parts that may be confusing and could be improved. Some steps may still be a little long, so a presumably last alteration 4 could also be used to shorten the steps further. Only steps that was affected by changes in alteration 4, are commented below:

- Although step 1 was discussed and language changed in alteration 3, the term "initiation" seem to be a point of confusion. In this context the term might be confused with organization(s) to take the lead in the benchmarking study. However, the previous argument of not using the word "participate" because of a possible mix up with the term "benchmarking partner", may have vanished while this term was changed in alteration 3 to "comparative companies and projects". If now using "participate", the benchmarking process model will consist of two groups of organizations, i.e. the "participating" and the "comparative". These terms should be well distinguishable for the users. Step 1 could thus be worded: "Decide on organizations to participate in the benchmarking study". However, the latter part could be considered superfluous, and it was taken out to shorten the step. The suggested new step 1 was: "Decide on organizations to participate".
- Step 4 had a comma added after the word "benchmark".
- Step 9 was also using the term "initiating" and had to be changed according to the changes in step 1. The word "all" was also taken out, and to be more specific the for instance abbreviation "e.g." was changed to the "i.e.". New step 9 was: "Decide

on strategy for adapting findings and implementing improvements, i.e. participating organizations together or separately".

- Step 10 needed a change of the term "initiation" as the above steps. It was also discovered that the way step 10 and step 11 was now, they might be understood as having an overlap, while both could be seen as making an improvement plan. Step 10 might seem a little long too, and was thus tried shortened. New suggestions for both steps were suggested to distinguish their difference and make them clearer. Step 10: "Adapt findings to improvement recommendations."
- Step 11: "Prioritize recommendations and establish a process improvement plan".

The steps after this alteration 4 are shown in Table 11.5.

Phases	Steps
Organize	1. Decide on organizations to participate
	2. Form a benchmarking task team and allocate resources
Plan	3. Define and understand all own project management processes
	4. Prioritize all processes and determine one to benchmark, based on e.g. improvement needs and potential gain of benchmarking
	5. Develop metrics and measures, and measure performance of own process
Find	6. Identify comparative companies and projects
Collect	7. Understand and document the comparative organizations' performance and practice
Analyze	8. Identify gaps in performance and the root causes for the gaps
Adapt	9. Decide on strategy for adapting findings and implementing improvements, i.e. participating organizations together or separately
	10. Adapt findings to improvement recommendations
Improve	11. Prioritize recommendations and establish a process improvement plan
	12. Implement improvements and monitor implementation progress

Table 11.5 Phases and steps after alteration 4.

At this point the phases and steps seemed to convey the important aspects of what was needed in a complete benchmarking study of project management processes. Although small changes and alterations could go on infinitely, it was decided to use the above suggestions.

11.2 DEVELOPING A GRAPHICAL REPRESENTATION FOR THE BENCHMARKING PROCESS

A graphical representation or visual appearance for the phases and steps in Table 11.5 needed to be developed to complete the benchmarking process model. At this point, some recommendations for a new graphical representation was made in the end of last chapter, based on the evaluation exercise of existing models.

The development of the graphical representation did not always follow a structural procedure. The development was more of a creative session, where ideas where thought of and books where checked for other kinds of graphical illustrations to get further ideas. Some of these ideas ended up in drawings for a model to represent the benchmarking process. Some drawings where immediately rejected, some where modified and rejected, while a few were brought forward and changed until one was finally decided upon. It was a try and fail exercise, until one representation made more sense than the others. To save space and time, only a few of these graphical representations are shown. Even if the structure of the development was not always streamlined, the following description of the development will try to convey the main points of the procedure that ended up in suggesting one model.

Trying the revealed types of graphical representation

The study of existing benchmarking process models had revealed four basic types of graphical representation, i.e. pure text, traditional flow chart, arrow flow chart, and circular. The recommendations included a dismissal of the circular representation, while it conveyed a continuos nature of benchmarking. The traditional flow chart representation was considered okay, but not preferred. Of the basic types of graphical representations revealed in the evaluation exercise, the recommendations preferred the flow chart arrow models type.

However, viewing the graphical representation and the benchmarking process, i.e. phases and steps, as totally separate entities should be avoided. The benchmarking process developed in the last section could display some specific features, e.g. to many phases or steps, that would contradict the previous recommendations. In order to determine if any such specific features where present in this benchmarking process, all revealed basic types of graphical representations were drawn, except the dismissed circular type. Figures 11.1, 11.2, and 11.3 show the new benchmarking process represented in the encountered 3 different basic types of graphics.

Organize	Decide on organizations to participate Form a benchmarking task team and allocate resources
Plan	Define and understand all own project management processes Prioritize all processes and determine one to benchmark, based on e.g. improvement needs and potential gain of benchmarking Develop metrics and measures, and measure performance of own process
Find	Identify comparative companies and projects
Collect	Understand and document the comparative organizations' performance and practice
Analyze	Identify gaps in performance and the root causes for the gaps
Adapt	Decide on strategy for adapting findings and implementing improvements, i.e. participating organizations together or separately
Improve	Adapt findings to improvement recommendations Prioritize recommendations and establish a process improvement plan Implement improvements and monitor implementation progress

Figure 11.1 Pure text model of the new benchmarking process

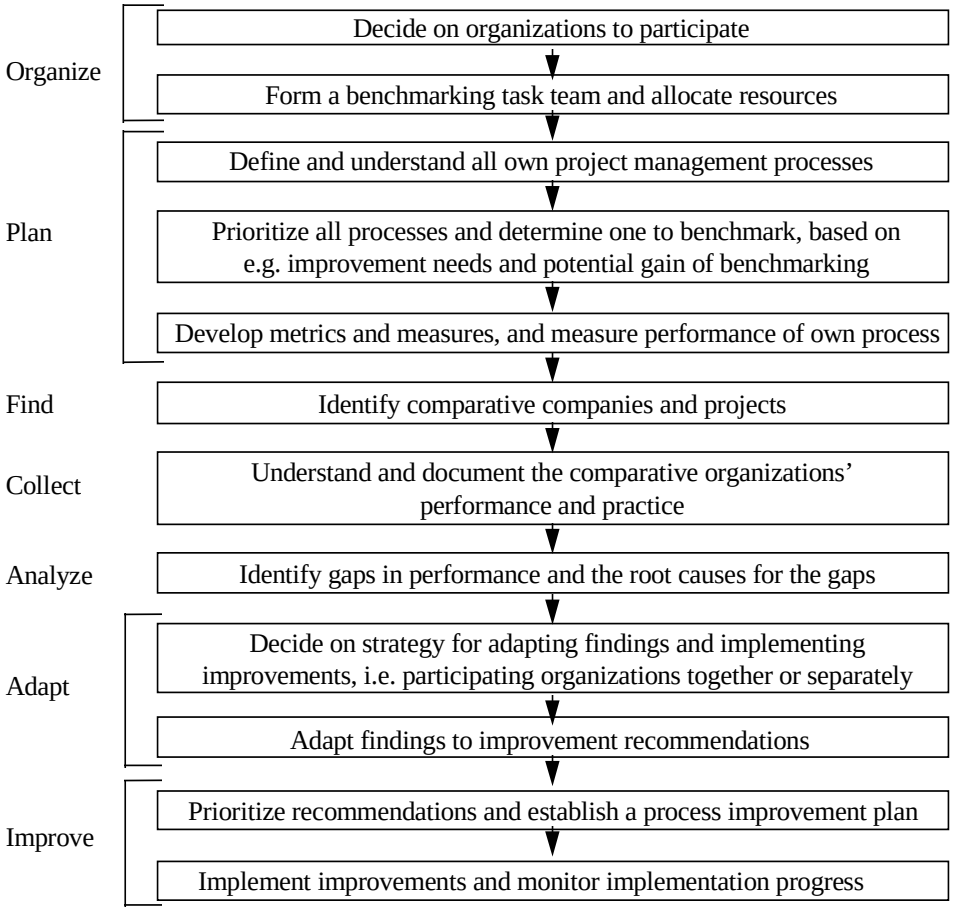
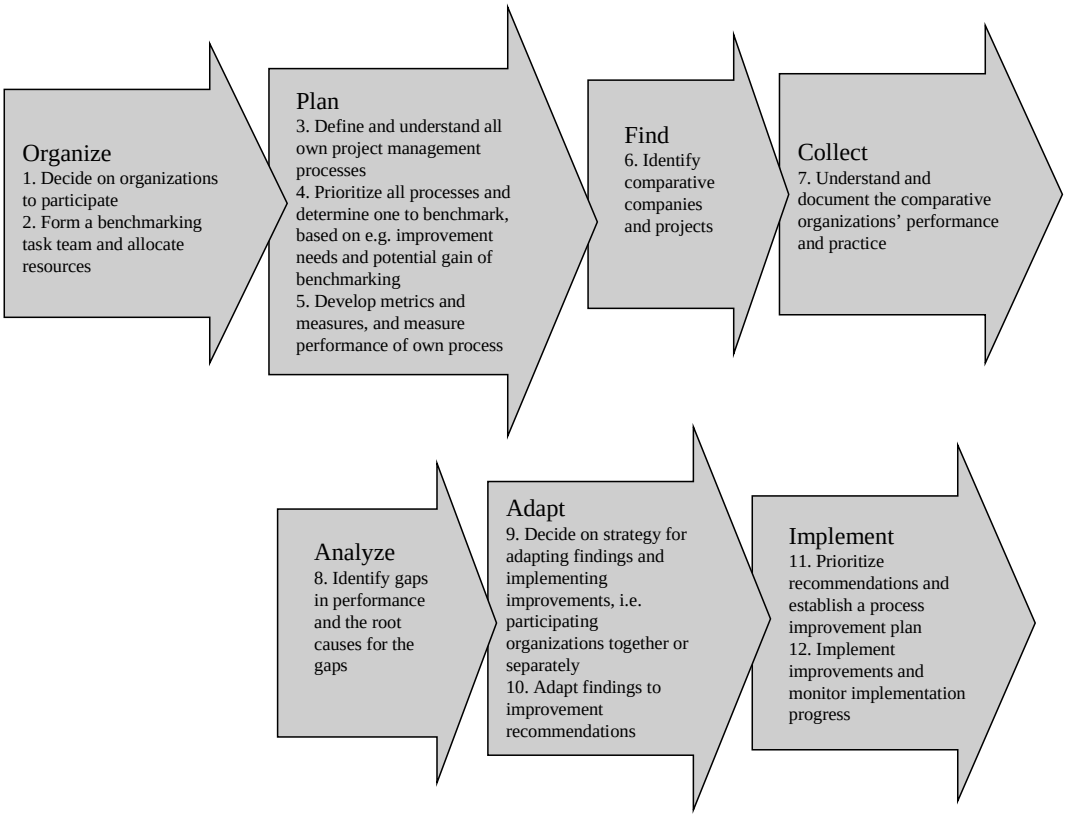


Figure 11.2 Traditional flow chart of the new benchmarking process



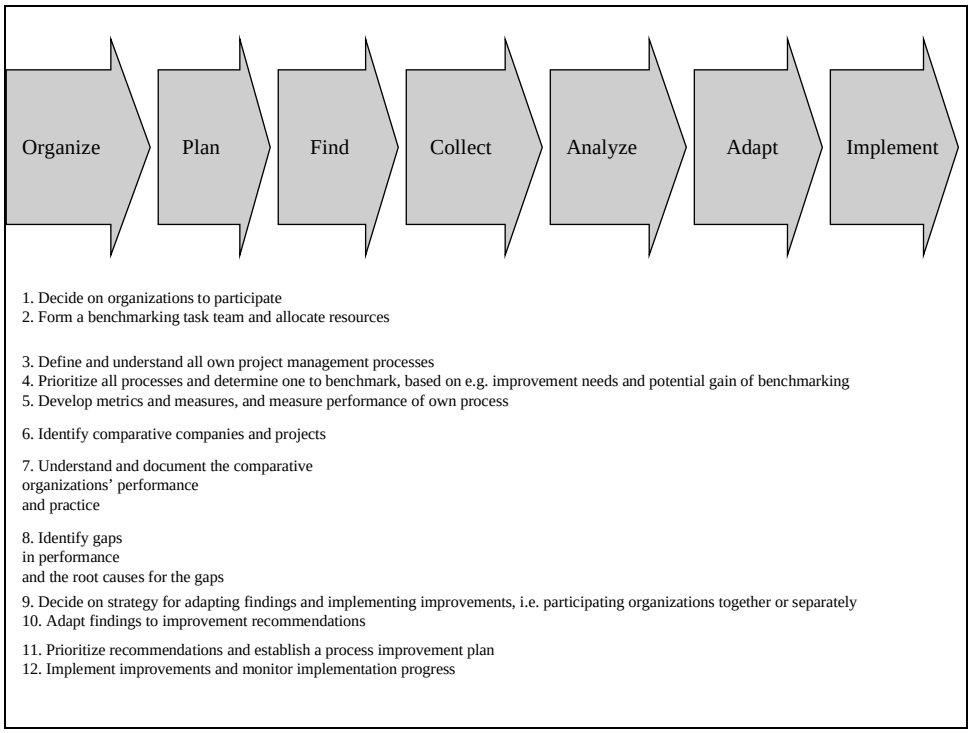
11.3. Flow chart arrow representation of the new benchmarking process.

In my opinion, the type of representation that came best out was the traditional flow chart in Figure 11.2. It was clean and conveyed both the phases and steps well. The previously recommended flow chart arrow representation in Figure 11.3 became untidy for three main reasons. One, the phases were in all 7 and were to many to be displayed in one line after each other without making the steps unreadable. Two, the phases contained an uneven number of steps, thus making them different in size. Three, the steps in themselves were of various length in wording, and consequently affected the size of the arrows, too. The combined effect of these three problems affecting the design, made the arrow flow chart not as appealing as hoped for.

Other graphical representation types and combinations of existing

Since the use of existing model's graphical representation did not suit the new benchmarking process adequately, new types of graphical representation had to be considered, as well as a combination of the existing ones.

The first try was to see if the arrow flow chart could be adjusted by taking out the steps, and only have the phases inside the arrows. Figure 11.4 shows the result. This representation was not satisfactory for two reasons. One, the steps do not fall in under their respective phases, there are simply just not room. Two, the steps are not really a part of the graphical display.



11.4 Arrow flow chart, taking out the steps.

Another attempt was to make the graphical representation look like an arrow, pointing in the up-right direction to give resemblance to this direction that for most diagrams and charts illustrate a bettering of conditions, i.e. improvement. The attempt is shown in Figure 11.5. It is an unfinished attempt, that shows same problems with number of phases and uneven number and length of the steps, as for the previous flow chart diagram attempt.

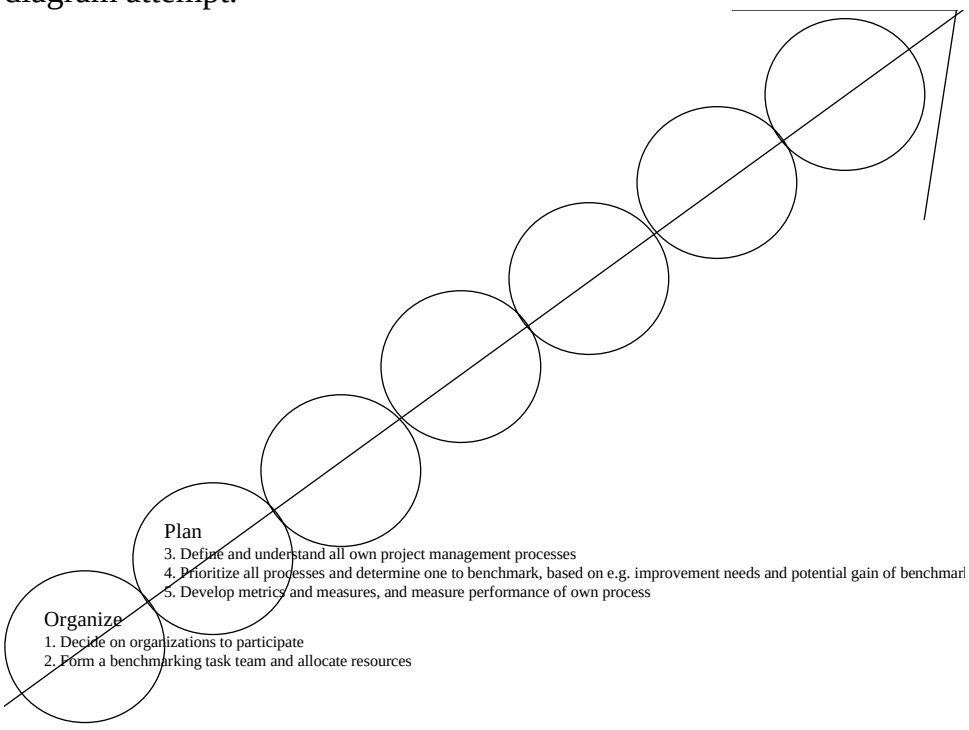
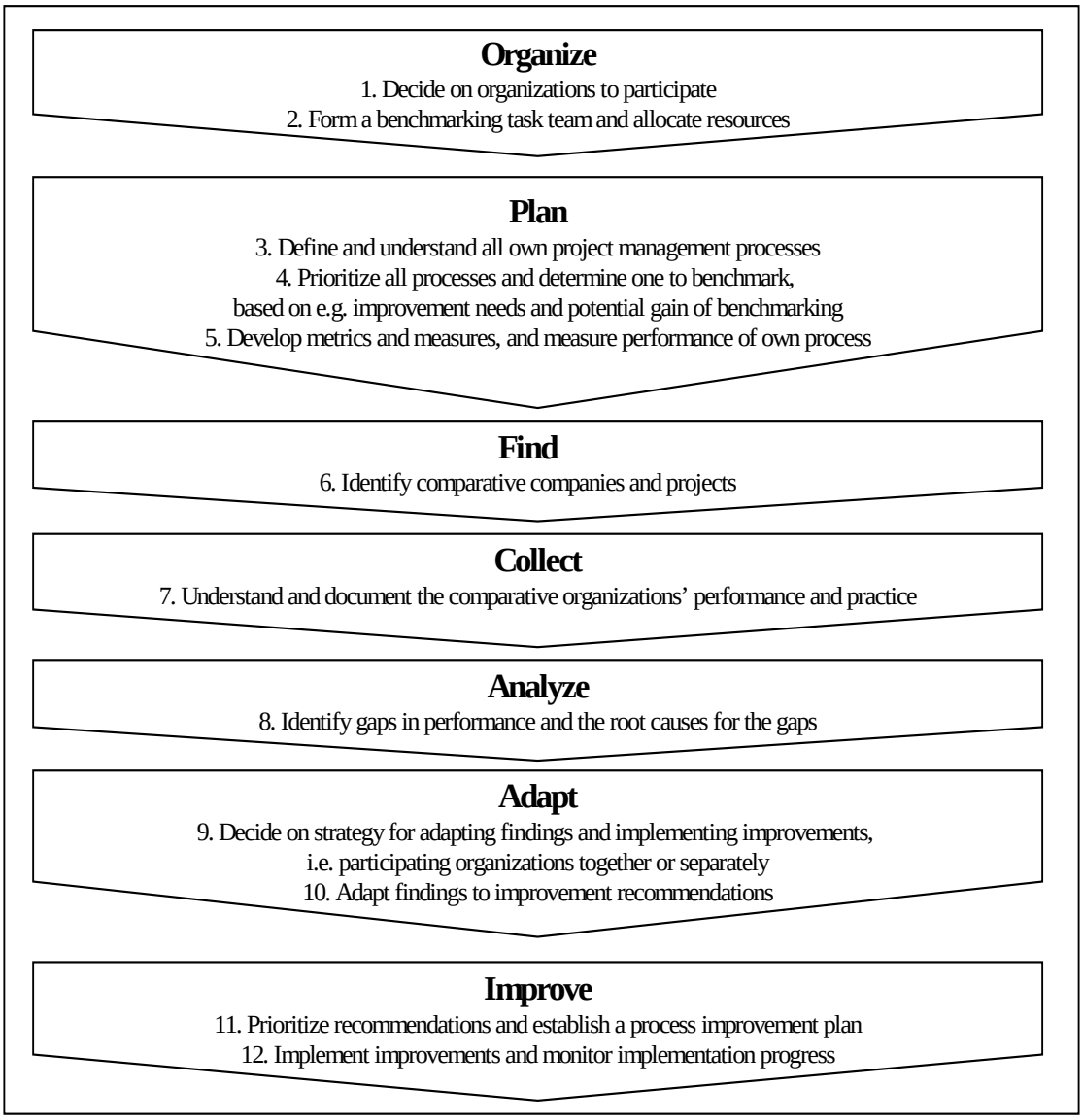
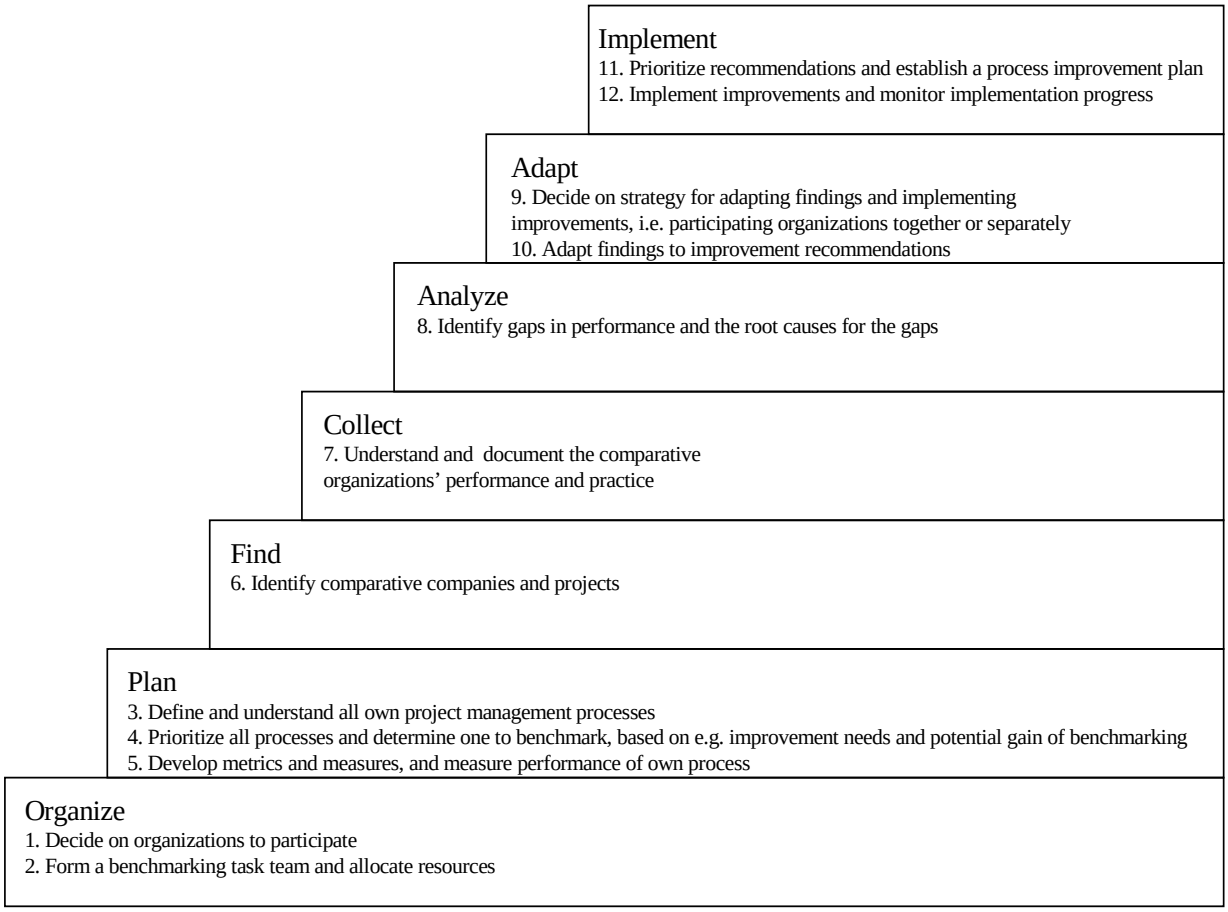


Figure 11.5 Attempt to make a graphical representation as an arrow pointing in up-right direction.

The two favorites that the above and other design attempts ended up with, are shown in Figure 11.6 and 11.7.



11.6 An arrow flow chart, combining the traditional flow chart with the arrows flow chart.



11.7 A stepwise presentation of the new benchmarking process, resembling stairs to climb in order to achieve improvement.

The first one, i.e. in Figure 11.6, is a combination of the traditional flow chart and the arrow representations. It shows in a clear and understandable way that the phases and steps are a part of a process. It also well divide the steps into it's respective phases. However, it is not resembling one of the key issues of the benchmarking process, i.e. improvement.

The latter model in Figure 11.7 shows the phases and steps in a step-wise display, resembling a staircase. The steps in the stair could represent the steps needed to be performed in order to reach improvement. However, it may not clearly show that the phases and steps are a part of one process, and it might be a little awkward to first read the phases in an up-right direction and the steps in a downward direction. For the model in Figure 11.6, the reading was just in one downward direction.

Which of these two representations that should be suggested to go forward with was a hard choice to make. Ideas for improving these two models were thought of. The "steps" could be improved by making the graphics look more like stairs, and by drawing an arrow following the direction of the steps to show the way to "go". Maybe place a "star" with "Improvement" written in it at the top of the stairs. The mixed

arrow and traditional flow chart, could be improved with colors/shades, and maybe draw new boxes for the larger phase-boxes, so they get less sharp arrow-heads in proportion with the other boxes.

However, which of the two representations this research decide on may not be a key issue, while they both seemed to be clear graphical representations. The graphical representation finally decided upon was the step-wise representation. The reason for choosing this was because it is resembling one of the key issues of the benchmarking process, i.e. improvement. After some small changes and attempts for improving the graphical representation, the decided upon representation is showed again in Figure 11.8.

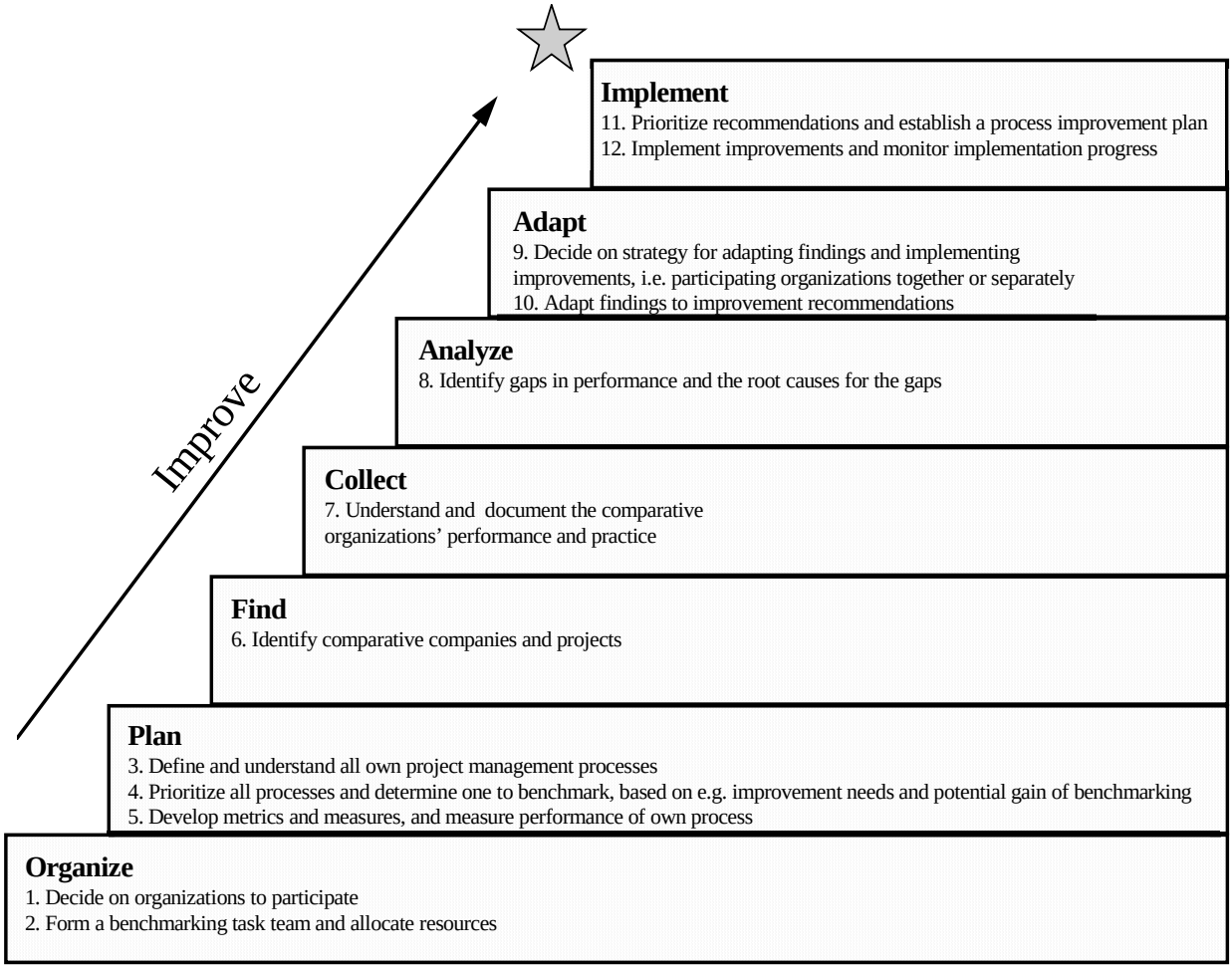


Figure 11.8 Decided upon graphical representation of the new benchmarking process model.

The above figure shows this research's suggestion for a new benchmarking process model made for benchmarking of project management processes.

12. EVALUATION OF THE NEW BENCHMARKING PROCESS MODEL

This chapter will numerically evaluate several existing benchmarking process models, based on the developed evaluation criteria. The new benchmarking process model will be evaluated textually and numerically, and be compared with the scores for existing models.

12.1 EVALUATION OF EXISTING BENCHMARKING PROCESS MODELS

The best way to evaluate the new suggested benchmarking process model would be to do a full scale benchmarking of a project management process following this new model, as well as a full scale benchmarking with the other existing models, and compare findings and results to see which model that gave best guidance. However, the time and resources required to do such a full scale testing for comparison of models, are not within the reach of this dissertation work.

Another way of comparing benchmarking process models was carried out by Andersen (1995). It was a numerical evaluation and this study pretty much follows the same evaluation procedure as the one used by Andersen. The major difference between Andersen's and this study's evaluations were the models the evaluation looked at, and the evaluation criteria themselves. As mentioned earlier, Andersen's and this study's evaluation criteria were developed for two different purposes. Thus, this study's evaluation leads to other scores on each specific model and other general findings.

As mentioned in chapter 10, both a textual and numerical evaluation of existing models were to be done, but with two different purposes. The previous textual evaluation was performed to evaluate the existing benchmarking process models fitness for guidance to benchmarking of project management. In addition, it was performed to acquire knowledge and establish recommendations for the work to develop a new model targeted for benchmarking of project management processes. The numerical evaluation of existing benchmarking process models was performed with the purpose of establishing means of comparing the suggested new benchmarking process model with the existing ones.

As for the textual evaluation, the numerical was also based on the developed criteria for evaluating benchmarking process models fitness for use at project management processes. (See Chapter 10). As chosen by Andersen (1995), this research also chose a three point scale to numerical mark the degree to which the models satisfy each of the evaluation criteria. The scale is explained in Table 12.1.

Mark	Meaning
0	Not or poorly satisfied
1	Satisfied
2	Excellently satisfied

Table 12.1 The three point scale for numerical evaluation (Andersen, 1995)

Andersen(1995) argued that a scale with only three points seemed more accurate in a testing than five, seven or ten, because a higher number of points would probably have made it more difficult to be consistent throughout the evaluation exercise of all the models. He argues further that a low number of marks, better elicited responses in the nature of "yes/no", that the evaluation criteria were designed for. The arguments made sense for the comparisons needed for this study as well. Thus, this study used a scale with only three points, in order to attain a precise subjective assignment of scores.

It was an option to weigh the criteria to reflect individual importance. However, many of the evaluation criteria carried equal importance and the weighing would have been subjective and difficult to perform. Besides, the evaluation criteria already possessed a kind of weighing. As previous mentioned, the benchmarking process model consisted of two main element, the benchmarking process and the graphical representation. The benchmarking process, i.e. phases and steps, were of these two by far the most important. Thus, having 8 criteria for the benchmarking process and 4 for the graphical representation, reflected a weighing somewhat in relation with their importance.

All of the 14 benchmarking process models listed in Table 10.1 were evaluated numerically. However, to present the detailed comments for each of these would require to much space and should be unnecessary. To show some of the considerations done when scores were assigned for each criterion, Table 12.2 shows an example evaluation of the Xerox model. The comments are excerpts from the previous textual evaluation of the Xerox model (in section 10.3).

Evaluation Criteria	Comments	Score
Process criteria:		
1. Steps	Number of steps okay, but some missing	1
2. Sequence	The covered steps followed a logical order	2
3. Organize	No coverage of organizing	0
4. Processes	No mentioning of the term ”process”	0
5. Overview	No activities focused on getting an overview	0
6. Metrics	The term “metrics” or was not used, but the development of it was indicated in step 3.	1
7. Improvement	Had high focus.	2
8. Understand	Covered steps were clear.	2
Model criteria:		
1. Key issues	Graphic emphasized that steps formed a process	2
2. Temporary:	Continuity intended, but graphics displayed temporary nature.	1
3. Understand:	Graphics easy to understand, grouping of steps helped further	2
4. Aesthetic	Used graphics, but were divided into too many details.	1
Total score:		**14**

12.2 Example of a numerical evaluation (the Xerox model)

The same procedure was followed when scores were assigned to the criteria for all the other models. Table 12.3 shows the scores for each criterion for all 14 models, as well as the total score (Please refer to Table 12.2 for the criteria names). Shown later in this chapter, these scores were used for finding the comparative strength of the new benchmarking process model.

Evaluation Criteria: Process models	1.	2.	3.	4.	5.	6.	7.	8.	1.	2.	3.	4.	Total Scores
Andersen	1	2	0	2	0	1	2	2	2	0	2	2	16
Andersen and Pettersen	1	2	0	2	0	2	2	2	2	0	2	2	17
Bendell et al	1	2	0	2	2	1	1	1	0	0	0	0	10
Berggren (TI)	1	2	0	0	0	0	2	2	0	1	1	0	9
Carey	1	2	1	2	0	1	2	1	1	1	1	1	14
Codling	1	1	0	2	1	0	2	1	2	0	1	1	12
Gustavsson (TI)	1	2	0	0	1	0	1	1	1	0	1	1	9
Harrington	1	2	0	1	0	2	2	1	1	1	1	0	12
Harrington and Harrington	1	1	1	0	0	1	2	1	0	0	0	0	7
Leibfried and McNair	0	2	0	0	0	1	2	0	2	2	2	2	13
Spendolini	1	2	1	0	0	0	2	2	2	0	2	2	14
Statoil	1	1	1	2	0	0	1	2	2	2	2	2	16
Thamhain	1	2	1	0	2	2	0	1	0	0	0	0	9
Xerox	1	2	0	0	0	1	2	2	2	1	2	1	14

Table 12.3 Existing benchmarking process models scores of an numerical evaluation.

12.2 EVALUATION OF THE NEW BENCHMARKING PROCESS MODEL

This research's suggested benchmarking process model was presented in the previous chapter in Figure 11.8. Five existing benchmarking process models were evaluated textually in chapter 10 based on the developed evaluation criteria. The new model was also assessed this way.

Textual evaluation

Process criteria

1. Steps: The twelve steps of the new benchmarking process contained sufficient activities to describe a complete benchmarking study. Twelve steps might seem to be many, but they seem also necessary to convey the needed information for a complete study. The seven phases grouped the steps, and emphasized as a heading the contents of the steps in each group.

2. Sequence: Each of the individual twelve steps represented different activities that were described in a logical sequence numerically. The graphical representation of these steps however, might distort this picture of logical sequence a bit. It may be a little awkward to first read the phases in an up-right direction and the steps in a downward direction. Thus, no steps seemed to be in an awkward order, but the representation of them is not perfect.

3. Organize: The benchmarking process focused on defining the organizational platform for the benchmarking study. One phase and two steps prove a strong dedication to the organization matter that was lacking in most of the other studied models. Thus, this important matter of a benchmarking of project management processes was met.
4. Processes: The project management process focus was well ensured, when step 4 specifically instruct to select a process for the benchmarking study. The word process was used 4 times in the model. Thus, the focus on project management processes was satisfactory.
5. Overview: Two steps were dedicated to get an overview of all project management processes before one is prioritized/selected for a benchmarking study. This activity was properly included in the model.
6. Metrics: The model specifically instruct to develop metrics and measures, and was thus adequately focusing on what was earlier described in this dissertation to be one of the major problems for benchmarking of project management processes.
7. Improvement: Improvement was emphasized well in the model. The term ”improvement” was used five times, and this criterion was fully met.
8. Understand: The steps were long, but the instructions were clear and the words used in the step were easy to understand. The division of steps into 7 phases made sense, and the steps presumably became easier to understand.

Model criteria

1. Key issues: The staircase that this model resemble, with one stair to climb for each phase, emphasize very well one key issue of benchmarking, i.e. improvement. However, the graphical sequence of activities are as mentioned earlier in process criteria 2, not in perfect order. Thus, the graphics do not show quite well the sequence of the activities into one process. The criterion was thus not fully satisfied.
2. Temporary: The steps stops at the top, and illustrate very well the temporary nature of benchmarking in the project environment. Thus, this criterion was met.
3. Understand: Even if the graphic representation of the model consist of many parts, the model is uncomplicated and easy to understand. It should not be hard to understand and memorize this model and its steps. To divide the 12 steps into 7 phases grouped into stairs, helped to make the model even clearer. Thus, the graphics served its purpose.
4. Aesthetic: The resemblance to a staircase, is clearly a plus and makes it clean to look at. The graphic may look a little “blocky”, so even if not perfect, in my opinion the graphics were quite aesthetic and appealing.

Numerical Evaluation

Numerical scores for the new benchmarking process model were assigned at the same time as the textual evaluation was done. Table 12.4 shows these scores.

Evaluation Criteria	Score
Process criteria:	
1. Steps	2
2. Sequence	1
3. Organize	2
4. Processes	2
5. Overview	2
6. Metrics	2
7. Improvement:	2
8. Understand	2
Model criteria:	
1. Key issues	1
2. Temporary:	2
3. Understand:	2
4. Aesthetic	1
Total score	**21**

Table 12.4 Numerical scores for the new benchmarking process model.

12.3 DISCUSSION AND CONCLUSION

The distribution of the numerical evaluation scores are shown in Figure 12.1.

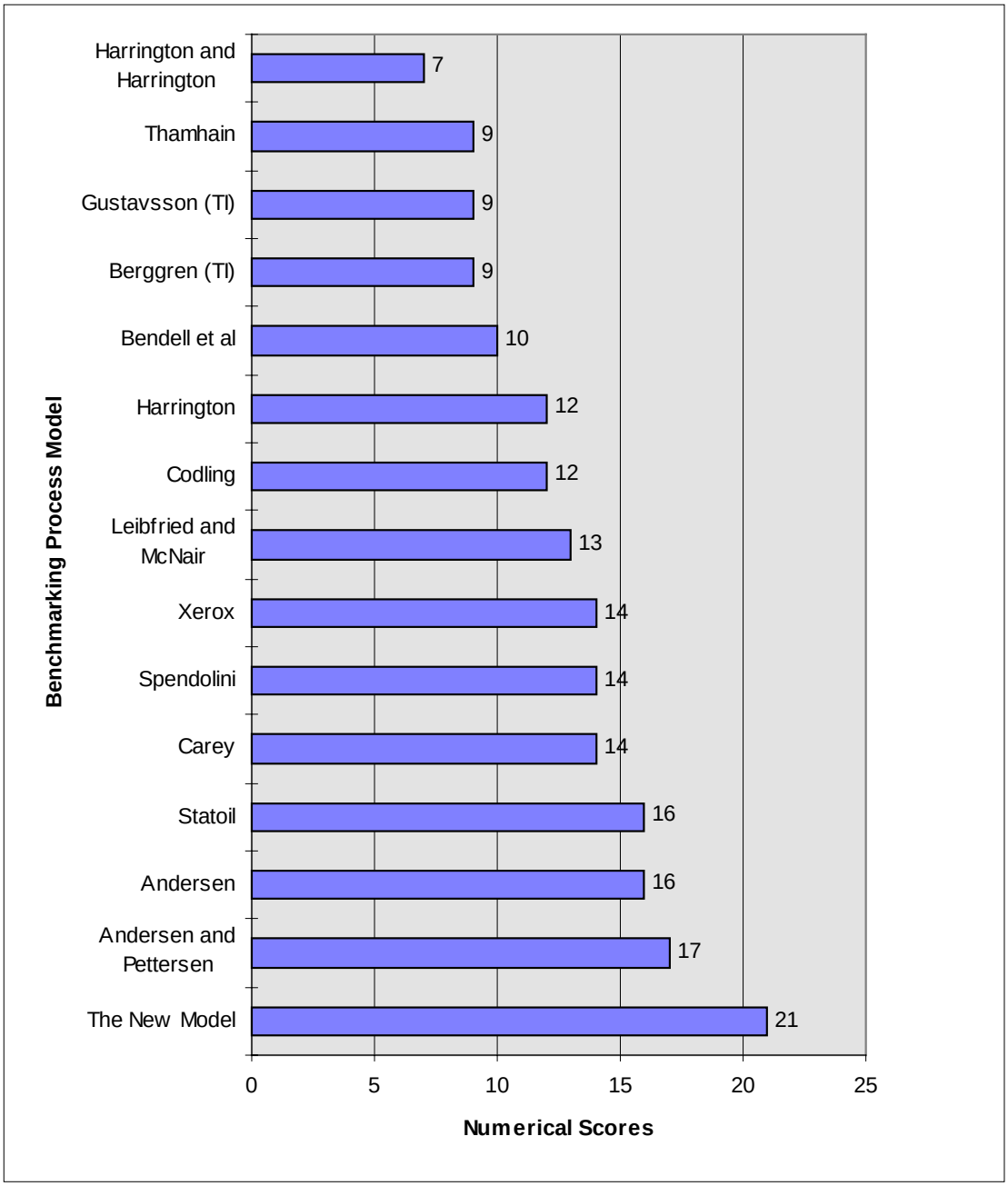


Figure 12.1 The distribution of numerical evaluation scores.

The numerical scores for the existing benchmarking process models ranged from ranged from 7 to 17. The new benchmarking process model got the score 21. The average score of the fourteen existing benchmarking process models was 12,3. The highest score of the existing ones where 17 for the model by Andersen and Pettersen. Thus, the new model had a score nearly twice as high as the average and twenty-four percent higher than the maximum score of the existing models.

Compared with the existing benchmarking process models, the new model appeared superior for benchmarking of project management processes. Thus, a new benchmarking process model had been designed, that compensated for some of the existing models' shortcomings to benchmark project management processes.

13. SUMMARY OF CONCLUSIONS AND FUTURE WORK

In this chapter, the findings for the 3 parts of my work described in the dissertation are briefly summarized. Areas for future work that could build on my work are also outlined.

13.1 SUMMARY OF CONCLUSIONS

Conclusions on Project Management Processes (Part I)

The project management processes defined by PMI was tested through a mail survey. The findings from the respondents' construction project perspectives, indicate strongly that all project management processes defined by PMI are all important and none are superfluous. The findings indicated further that for some projects, the project management processes by PMI were quite complete, but for others there are missing project management processes. In the participants opinion, the PMI developed project management processes illustrate quite well the project management processes on their reference projects and for constructions projects in general. It is thus reasonable to believe that the PMI processes quite well illustrate project management processes in construction type of projects.

In the same mail survey, questions were asked in order to indicate areas or processes of project management where improvement needs were highest, i.e. where improvement efforts like benchmarking should focus. The participants were asked for their opinion of importance and performance to each of the 37 PMI project management processes. The findings includes that the project management processes performed early in the reference projects, i.e. initiating and planning processes, were identified to be of highest need of improvement. For the individual project management processes, the participants' answers indicate that the following 12 had the highest need of improvement. In order of improvement need, the processes are:

1. Initiation
2. Risk Identification
3. Communications Planning
4. Organizational Planning
5. Staff Acquisition
6. Scope Planning
7. Risk Quantification
8. Quality Planning
9. Team Development
10. Schedule Development
11. Quality Control
12. Cost Estimating

Conclusions on Metrics (Part II)

No metrics encountered in literature or existing research has been developed for project management processes directly. Furthermore, no set of metrics that directly focus on project management only was encountered. Several of the metrics developed in existing work on metrics and benchmarking, e.g. project metrics, may be similar to

metrics that can be used for some project management processes. However, they do not amount to fill in for all processes, and the existing metrics needs to be adjusted or adapted to the relevant project management process.

This research therefore developed metrics for the 37 PMI defined project management processes (see chapter 7). This work has been based on a combination of encountered metrics in the literature, inputs from interviews with experienced project management personnel, and creative thoughts of the author of this dissertation. However, the suggested metrics to each project management process are not meant to be universal metrics for the project management processes in question. The list of metrics are meant to be a place for potential benchmarkers to look to get ideas for their own project management processes. In other words, the metrics are not meant to be used directly, but need to be adjusted to the project management processes of the organization in question.

Using the suggested lists of metrics, metrics to one project management process was tested in a survey part 2 to get some feedback on the metrics work. The process was Risk Identification. As a whole, the participants leaned clearly towards a positive opinion to the suggested metrics.

Conclusions on Benchmarking Process Models (Part III)

A sample of existing benchmarking process models has been evaluated, in order to see if they were fit to guide in a benchmarking of project management processes. The research concluded that none of them could guide users through a complete benchmarking study of project management processes. The evaluation exercise most importantly led to an increased knowledge about what constituted strong and weak sides of such models. This knowledge was in turn applied during the design of a new benchmarking process model fit for project management processes.

Applying findings from the evaluation of the existing models, the steps for a new benchmarking process was developed through a transformation process of a selected existing model. A graphical representation for the benchmarking process was developed through a combination of a creative session and studies of different categories of existing graphical representations. This research suggest a new benchmarking process model, shown in Figure 11.8, targeted to fit benchmarking of project management processes.

A numerical evaluation of the new benchmarking process model, showed that it scored highly throughout the entire set of evaluation criteria. The new model scored twice as high as the average score, and it scored twenty four percent higher than the maximum score, of the existing models. Compared with the existing benchmarking process models, the new model appeared superior for benchmarking of project management processes. Thus, a new benchmarking process model had been designed, that

compensated for some of the existing models' shortcomings to benchmark project management processes.

13.2 FUTURE WORK

Based on the work undertaken in all parts of this dissertation, one main effort for further study stand out. That is a full testing of the new benchmarking process model through real-life benchmarking studies. Such a real-life testing could bring further the work from all parts of this dissertation, including the following:

- Objective testing of the benchmarking process model.
- Development of missing project management processes
- Comparison and updating of this dissertation's indications of project management processes in most need of improvement
- Updating and improvement of this dissertation's list of suggested metrics

A further discussion of these points follow below.

This dissertation research's part three focused on designing a new benchmarking process model targeted to fit benchmarking of project management processes. This design process ended up in an evaluation of the new benchmarking process model and comparison of its score to the scores of existing models. With respect to benchmarking of project management processes, the evaluation concluded that the new model was superior to the existing models.

This evaluation represented my objective assessment of both existing models and the new developed model. A natural succession of my work would be a more objective testing of the model. The new benchmarking process model should be used to perform real-life benchmarking studies of project management processes in order to more objectively evaluate and test its use and possible results. Such a test would be ideal, if a parallel real-life testing could be conducted with some of the existing benchmarking process models as reference experiments. A creation of such a laboratory environment in any organizations is probably not a realistic goal, but some sort of objective and real-life testing of the new benchmarking process model should be conducted.

Such a real-life testing of the benchmarking process model developed in the third part of this dissertation, would involve a testing and updating of the other two parts of the dissertation, too. The new benchmarking process model involves steps that could bring in further testing and updating on research concerning both project management processes and metrics. These steps include:

Step 3: Define and understand all own project management processes
Step 4: Prioritize all processes and determine one to benchmark, based on e.g. improvement needs and potential gain of benchmarking.

Step 5: Develop metrics and measures, and measure performance of own processes.

The work undertaken in first part of the dissertation on project management processes, included a finding that there are missing project management processes among the 37 defined by PMI. A real-life benchmarking study, involving step 3 above, could fill in for some of these missing project management processes. Furthermore, a real-life study involving step 4 could lead to one specific organizations prioritization of project management processes after their own improvement needs. This prioritization could be compared to the dissertation's listings of the project management process after improvement needs, indicated by the survey. It is important to realize that the list of project management processes after improvement need will change with time. If the process with the highest need of improvement is significantly improved, it will not belong on top of the list anymore. Thus, a continuos updating of such a listing is essential.

In addition, a real-time testing involving step 5, could be a testing of the suggested metrics listed in the second part of this dissertation. The feedback from this testing and the actually used metrics, could add to, update, and improve the list of suggested metrics. In order to keep the metrics lists for project management processes as a good reference book to where potential benchmarkers can get ideas to metrics for own processes, it is essential that also these lists are continuously improved and updated.

There are one further area for research not summarized above, that should be mentioned. My work focused on defining quantitative measures, i.e. metrics, for project management processes. In order to do a benchmarking study of project management processes, qualitative measures need to be identified and defined as well. No set of qualitative measures were encountered during this dissertation work. Although this research's tables with suggested metrics also lists some qualitative measures, they were not in focus. A focus on defining qualitative measures is recommended for future research.

LIST OF LITTERATURE

The list of litterature includes references and relevant readings. References are marked with an asterisk (*).

*American Productivity and Quality Center (1993) *The Benchmarking Management Guide*, Productivity Press, Cambridge, MA, USA.

American Society of Civil Engineers (1988) *Quality in the Constructed Project: A Guideline for Owners, Designers and Constructors*, Manual for Professional Practice, Volume 1, Preliminary edition for trial use and comment, USA.

*Andersen, Bjørn (1995) *The results of benchmarking and a benchmarking process model*, Ph.D. Dissertation 1995:81, The Norwegian Institute of Technology, Department of production and Quality Engineering, Trondheim, Norway.

*Andersen, Bjørn (1995b) *Discussions* between the dr.ing./ph.d. student and Dr. Andersen in oktober and november 1995 on the topic: benchmarking of project management, Andersen is an Associate Professor at Norwegian University of Science and Technology (NTNU).

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NS-ISO 9002 Kvalitetssystemer. Kvalitetssikring ved tilvirking og installasjon.
NS-ISO 9003 Kvalitetssystemer. Kvalitetssikring ved sluttkontroll og sluttprøving.
NS-ISO 9004 Kvalitetsledelse og-systemelementer. Retningslinjer.

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APPENDIX A: SURVEY AND INTERVIEW TARGETED PERSONNEL

Below are personnel knowledgeable of project management, contacted for participation in the surveys or interviews. They are listed after their organizational belongings. In the last three columns, an "x" marks where they have participated, "(x)" marks that their answer where received to late to be included, and "n" marks a response that for some reason they could not participate. Blank would mean no participation.

Person	***Organization***	***Interviews***	***Survey part 2***	***Survey Part 1***
Donatella de Paoli	AFF NHH			n
Per Ove Aftreth	AF-Spesialprosjekt a.s.		x	x
C. Hilton Dunn	BE&K			
Sigurd Uggen	Berdal Strømme			n
Else Karine Stangeland	Berdal Strømme			
John Borcherding	Borcherding Enterprises Inc.			x
David G. Hile	Cherne Contracting			
T. Kirk Morrow	Construction Industry Institute	x		x
Charles McGinnis	Construction Industry Institute		x	x
Richard L. Tucker	Construction Industry Institute			x
David N. Hudson	Construction Industry Institute			
Thorhallur Gudmundson	Control Bridge			(x)
Otto Husby	Control Bridge			
Eilif Holen	Cost Engineering as			
J.J.Suarez	CSA North America, Inc.			
Petter Berntsen	Duke Construction		x	x
Debbie Grubbe	DuPont			
Paul Reinhard	DuPont Company			x
J. K. Derrickson	E.I. DuPont de Nemours &Co.,Inc.		x	x
Ralf Hansen	Elf Aquitaine Norge			
Per Willy Hetland	EPCI/Statoil			x
Harald Lekven	Erstad & Lekven			
Olaf Dobloug	Forsvarets Bygningstjeneste		x	x
Tor Berntsen	Forsvarets tele og datatjeneste	x		
Arthur Guerra	Guerra Construction Co.			
Svein Arne Jessen	Handelshøyskolen BI			
Don W. Stojanic	Hoechst Celanese Chemical Group			x
Noel V. Smith	Hoechst Celanese Chemical Group		x	x
Roger Miller	IMEC Research Programme			
Tracy Ernsting	IMEC Research Programme			
Pascal Michaud	IMEC Research Programme			
Brian Hobbs	IMEC Research Programme			

Sjur Stumo	Intersoft			n
Knut Sjøvold	Jernbaneverket		x	x
Per Arne Fredriksen	Jernbaneverket			
Knut Harald Granheim	Kværner Energy			
Arne Lambertsen	Kværner Engineering			x
Wilhelm Horn	Kværner Engineering			x
Jan Håkon Shetelig	Kværner Engineering			
Håkon Brydøy	Kværner Installasjon		x	x
Simen Lieungh	Kværner Oil&Gas			x
Jan Gunnar Vallaker	Kværner Rosenberg			
Sotiris Pagdadis	Lambousa Infrastructures			(x)
Jan A. Bakken	Metier Scandinavia			x
Harald Vasall	Metier Scandinavia			
Torbjørn Tennmann	Metier Scandinavia			
Bjørn Arne Walberg	Metier Scandinavia			
Milan Moravec	Moravec & Associates			
Ralph S. Spillinger	NASA Headquarters		x	x
Gustav Lasota	National Swedish Fortifications Administration	x		
Fredrik Ystehede	Norplan AS			
Morten Kristoffersen	Norsk Hydro		x	x
Håvard Skaldebø	Norsk Hydro	x	x	x
Henrik Glette	Norsk Hydro			x
Wiggo Moen	Norsk Hydro			n
Thor Tangen	Norsk Hydro			n
Morten Marøy	NTNU	x	x	x
Kjell Austeng	NTNU			x
Rune Espedal	Oljeindustriens landforening			n
Hans Riddervold	Oljeindustriens landforening			n
Jostein Ravndal	Oljeindustriens landforening		x	x
Jonathan S. Schultz	Phillips Petroleum Company			
Daniel G. Streyle	Procter & Gamble		x	x
Terry Hoffman	Procter & Gamble			
Ole Johnny Klakegg	Prosjektstyring AS		x	x
Sven Erik Nørholm	Prosjektstyring AS			n
Tarjei Kristian Hemstad	Saga Petroleum			n
Trine Ulla	Saga Petroleum			
Pål Gjersø	Saga Petroleum			
Knut Samset	Scanteam International AS			n
Gunnar Ova	Selmer A/S			x
Agnar Johansen	SINTEF Teknologiledelse	x	x	x
Halvard Kilde	SINTEF Teknologiledelse		x	x
Bjørn Berge Hansen	Statens vegvesen Akershus			x
Olav Landsverk	Statens Vegvesen Akershus		x	x
Hallgeir Nordahl	Statens vegvesen Akershus			
Tone Nakstad	Statens vegvesen Vegdirektoratet			
Arne Sandvold	Statkraft Anlegg AS			x
Finn O. Sandberg	Statoil			
Ernst Abrahamsen	Statoil			

Per Tønnessen	Statoil			
Ingemund Jordanger	STATOIL F&U	x	x	x
Jan Roger Olsen	STATOIL Site Team Åsgard Project			x
Øystein Meland	Statsbygg	x	x	x
Ronald Sørgaard	Statsbygg			n
Stein Rognlien	Statsbygg	x		
Ulf Trøen	Telenor forskning			
Einar Skåre	TerraMar Prosjektledelse		x	x
Jon Østensvig	TerraMar Prosjektledelse			x
Saleem M. Khan	Texas Energy Engineering Services, Inc.			x
John L. Rose	The M.W. Kellogg Co.			
Calin Popescue	The University of Texas at Austin	x		x
Oddwin C. Skaiaa	TRANOR AS		x	x
Stig Jessen	UMEO Technology			x
Francis Hartman	University of Calgary			
Ali Jaafari	University of Sydney			n
Edward Gibson	University of Texas at Austin			x
Kirby Perry	University of Texas at Austin			
Eugene George	University of Texas at Austin			
Jeffrey S. Russell	University of Wisconsin, Madison			
Øyvind Larsen	Veidekke as			x
David J. Tweedie	Watkins Engineers & Constructors			
Rolf Gundersen	West Soft			x
Hans Hjørring	West Soft Project			x

APPENDIX B: COVER LETTER AND QUESTIONNAIRE TO SURVEY PART 1

The cover letter and the questionnaire for survey part 1 are shown in the following 9 pages.

APPENDIX C: COVER LETTER AND QUESTIONNAIRE TO SURVEY PART 2

The cover letter, a letter with additional information, and the questionnaire for survey part 2, are shown in the following 8 pages.