UNIVERSITY OF OSLO
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Criteria for Successful CMM-based Software Process Improvement

Experiences from two CMM-based assessments

Cand Scient thesis

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21st December 2004

Abstract

Software Process Improvement includes changing the way people work and use software, and CMM is a model for the description and assessment of maturity in a company's work with software development with focus on the development processes. Based on an interpretive case study in two departments in Norway's largest telecommunications company using two different approaches to CMM-based assessments, I define prerequisites for success for using the methods and for software process improvement in an organization like the one at hand. A quantitative approach could be used when CMM concepts are institutionalized in the organization and the goal of the assessment is CMM compliance, to measure Software Process Improvement progress, or evaluate CMM appropriateness in the organization. A qualitative approach should be used when the goal is to get in-depth information about good and bad practice and to locate improvement areas, and when the appraisal team has the necessary skills. The prerequisites that need to be in place to ensure success of CMM-based Software Process Improvement are commitment, management, participation, and risk management.

Preface

After 2 years with exciting courses and thesis related work I am left with knowledge and experience I would not do without. If everything goes as planned I will soon be able to use my expertise and learn a lot more about this exciting field in practice.

First of all I would like to thank my adviser, Geir Amsjø, at Department for Informatics at UIO for expert guidance regarding my cases at Telenor and CMM. I would also like to thank Pål Sørgaard, my adviser at Telenor Research & Development, for helping me defining cases at Telenor and for advice along the way. Thanks to Bjørn Ketil Sveen and Bjørn Remseth who coordinated the cases at Telenor, and thanks to all participants in the assessments at Telenor.

To friends and family who have supported me and shown interest in my work: thank you for the motivation you have provided me! And a special thanks to David, who so kindly have read through most of my work and humbly made corrective suggestions – and to Afsheen and Kamran for reading through and commenting this thesis.

Oslo, 12/22/2004

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1 Introduction

This thesis concerns *Software Process Improvement*. Software Process Improvement involves changing the way people work when developing software to be able to deliver higher quality products. In the following chapters of this work I will refer to Software Process Improvement as SPI.

SPI activities are initiated based on experienced challenges that businesses face. These challenges can be market related; customers experience that expectations are not met in the form of exceeded budgets, quality problems, delays in delivery, or that competitors deliver products faster and show improvement. Changes in the market can also require improvement; Customers are more demanding, and their quality requirements are higher because there is a more critical use of software than earlier; the market requires more deliveries in shorter time than before. Organizational contexts like distributed groups/department, organizational growth and mergers and acquisitions also require predictable ways of working. To overcome these challenges a business should assess "how we work with software" to locate potential improvement areas to be more predictable when developing software, and to be able to adapt to fast-changing environments to stay ahead of competition.

1.1 Software Process Improvement

Software processes are complex processes. Software processes can be understood as those activities, people, and systems involved in the development, maintenance and use of software systems. Developing complex software products makes it hard to estimate resources needed in the process, and hence makes the software process itself complex. A complex process is hard to optimize, and because software processes are performed by humans, the complexity is even higher: human behavior is hard to predict. Before making a decision about what areas need improvement, an analysis of how things are actually done in the organization should be conducted. An assessment of the current situation in an organization regarding software processes is the starting point for a process improvement program. An assessment helps to identify strengths and weaknesses of the software processes and pinpoints what areas that need improvement. This calls for enablement of improvement of the organization's software processes, as improved processes can lead to improved products in form of lowered costs etc and can improve an organization's customer relations. Continuous process improvement calls for a process improvement process. Several models for improving the software process have been defined and tailored for software development, like SEI's IDEAL process [McFeeley, 1996, Gremba & Myers, 1997], Deming's Plan/Do/Check/Act [Deming, 1986] and Basili's Quality Improvement Paradigm (QIP) [Basili, 1985]. The improvement process includes two major activities: assessment of the

current software process and an evaluation of the software process improvement efforts. One of the existing models for assessing the software process is the Capability Maturity Model [Paulk, Weber, Curtis & Chrissis, 1994].

1.2 Focus area

There are many approaches to SPI, and the work conducted in relation to this thesis is based on a reference framework widely used in software process evaluations and improvement work, the Capability Maturity Model for Software [Paulk, Curtis, Chrissis & Weber, 1993]. In the following chapters of this work I will refer to the Capability Maturity Model for Software (SW-CMM) as CMM as defined in Paulk, Curtis, Chrissis & Weber (1993).

Focus in this thesis will be on practical use of the model and evaluation of two different approaches to use of the framework. The method evaluations are based on two cases conducted in the leading Norwegian telecommunications company Telenor. In relation to the cases I will discuss how the organization has to prepare for and commit to the work being done to accomplish real improvement, in addition to humbly making recommendations regarding SPI efforts in Telenor.

1.2.1 Capability Maturity Model for Software

The SW-CMM is a reference model in software process improvement within software development that has had big success the last decade. The model is used as a standard for measuring the value of an organization's existing software development process; at the same time as the model is a guide for identifying and prioritizing the efforts in the process improvement effort. The CMM framework is developed at the Software Engineering Institute [http://www.sei.edu/] at Carnegie Mellon University. The framework demonstrates key elements in an effective systems development process and describes an evolutionary improvement process in five levels for systems development, from an ad hoc, immature process to a mature, disciplined process [Paulk, Weber, Curtis & Chrissis, 1994].

1.3 Motivation and contribution

My motivation for conducting the research in this thesis has been to learn about SPI in practice, and to learn how the CMM framework is used in businesses – what are the motivations and the approaches to using the framework, and what should a business focus on when selecting one approach instead of another? What challenges does a business like Telenor meet when initiating SPI, and how can the company overcome these challenges to ensure lasting SPI? These are some of the questions I wanted to answer. I hope that businesses similar to Telenor can learn from the successes and difficulties we experienced, both in terms of initiating SPI using the CMM framework, and when selecting approach to CMM-based SPI.

1.4 Problem description

The motivation for initiating maturity assessments in an organization can typically arise from one of the following:

1. Identification of specific areas for improvement based upon known general areas of deficiency.
2. Confirmation of known data on the systems engineering process.
3. Obtaining commitment for change in organizations.
4. Confirmation on process improvement process.

[Frey-Pučko, Novak & Kandus, pp. 273, section 2, line 17-23, 2001].

The telecommunications' business is experiencing increased competition and this affects priority goals for the competitors in the market. In addition to continuous introduction of new technology, development of stabile and useable products within budget and delivered to the time that has been agreed upon has become critical factors of success. This can be assured through adequate maturity of the software process and product quality. CMM provides a common basis for process management and quality improvement concepts in software/systems development and maintenance. [Frey-Pučko, Novak & Kandus, 2001, p 272]. To link the motivations mentioned above to the cases described in this theses, the motivations from an organizational perspective in Telenor were motivated by:

1. Confirmation of known data on the systems engineering process.
2. Obtaining commitment for change in organizations.

(This will become clearer in the *Case Descriptions* chapter regarding goals of the assessments)

1.4.1 Prerequisites for successful SPI in an organization like Telenor

SPI is an organizational change process that introduces improved methods, tools, techniques, as well as awareness, and thereby attitude about these issues in the organization [Humphrey, 1989, McFeeley, 1996]. It is important to consider the organizational context the SPI effort should be a part of when initiating the work, and there are several issues to consider. To be successful, SPI requires deep insights and understanding of an organization's software processes in order to identify problems and to define and implement an improvement strategy [Iversen, Nielsen & Nørbjerg, 1999]. What issues does an organization like Telenor need to consider being successful with SPI?

I will argue that the success criteria for successful SPI in this type of organization are the following:

Success Criteria	Includes issues related to
Commitment	Available resources, SPI goals aligned with business goals, realistic expectations, management support
Management	Change perspectives, organization, training, plan, feedback
Participation	Empowerment, organizational learning, institutionalization
Risk management	Norm-based SPI

1.4.2 Using CMM in Telenor for measuring software process maturity

Different approaches can be used for measuring maturity in an organization, and to identify areas of improvement. Factors like use of resources and goals, both business goals and specified goals for the improvement work will affect management's decision on how the assessment shall be conducted, and thereby what data are left to be analyzed. To understand what the specific problems are, an organization can rely on normative process models like CMM or Bootstrap [Kujava & Bicego, 1994], or base the diagnosis of situations in the organization on the employees' perception of problems in the software processes without using a framework to define "good practice". Most SPI projects use normative models to guide the SPI process and to assess current practices and the identification and prioritization of improvement initiatives. When using a framework like the CMM, tailoring the

framework for the specific organizational context is necessary. Most organizations today use one or more of the CMM models as internal software process improvement frameworks: they have no intention of benchmarking the organization or taking advantage of the market value a CBA IPI [Dunaway & Masters, 2001] or SCAMPI [SEI, 2001] assessments has. The challenge for organizations is to find the best approach to take when using the CMM and this is also a challenge for Telenor.

1.4.3 Successful Software Process Improvement using the CMM in Telenor

In this thesis I aim at addressing some of the necessary premises for an organization like Telenor to be successful in their SPI effort when using the CMM framework as a guide. Part of the work is based on two software process assessments conducted in two different departments in Telenor. The thesis will include a discussion of basic assumptions behind successful SPI efforts, in addition to a discussion of the CMM-based assessment processes, to try giving an answer to which method seems most valuable in this type of organization.

Research Questions:

Premises for successful CMM-based SPI in an organizational context:
1. What are the experiences from the assessment processes?
2. Which method seems to be the best one in a setting such as in the organization at hand?
3. What prerequisites were present in the organization when the assessments were initiated? How did the SPI efforts fit into the organizational context? How was the SPI effort managed?
4. Lessons learned: what are the prerequisites for successful CMM-based SPI in this type of organization?

To answer these questions there are several perspectives that need to be considered:
- The methods used in the assessment process:
  - A developed and tried tool for quantitative measurement of the organization for CMM level 2

- o A qualitative measurement based on experience and knowledge about the organization and the CMM
- ➢ At what levels the department focus their development:
  - o Development of new systems
  - o Development on old systems
  - o Maintenance: corrections, small changes and support
- ➢ What are the necessary circumstances in the organization for initiating successful SPI:
  - o Timing in relation to other organizational happenings
  - o Involved people
  - o Knowledge about and experience in SPI
  - o Desire to improve

1.4.4 Approach

In an attempt to answer the research questions above, two cases will be referred to. One case is from Telenor Mobil's IT department[1], which during the summer of 2003 conducted a quantitative CMM-based assessment to measure the department's maturity in relation to CMM level 2.

The other case is from Telenor Business Communications, the department for Information Systems and Project Management (ISPM), which conducted a qualitative CMM-based assessment to measure the department's maturity in relation to CMM level 2.

Both departments consist of groups that perform differing types of tasks. The tasks can roughly be categorized into:

1. Development/Project work and
2. Maintenance/Assignments from the line organization.

How relevant a CMM-based assessment is to a specific department depends on how well the CMM language and concepts seem to fit the organizational context. It is necessary to interpret and tailor the CMM framework to the organizational context to get valid and useful data to work with in the SPI effort.

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[1] Telenor Mobil is a unit within Telenor, and the English translation would be Telenor Mobile. However, Telenor Mobile is an overall business area for Telenor and I will use the Norwegian name for the unit under study in this work so the reader will not mix it with the business area Telenor Mobile.

1.5 Method

The research method used in this thesis is a case study and a literature study. The case study was conducted in two departments in Telenor and be described as parts of the phases in action research.

The action research in Telenor Mobil IT was based on a conducted survey with questions from a CMM questionnaire used by SEI assessors when assessing an organization's maturity [Zubrow, Hayes, Siegel & Goldenson, 1994]. The survey was structured in a pre-developed tool [Kristensen, 1998] that generates result reports based in the registered responses and included all employees in the department. The appraisal team used the reports from the tool to evaluate the results before presenting them to the leaders of the different groups within the department for them to participate in the selection of process areas to improve in the department.

In ISPM the action research was based on interviews in line the SEI's CMM-based appraisal method for internal process improvement. A selection of employees where interviewed both to locate best practices and to evaluate the CMM's appropriateness for the department. Additional interviews were conducted to locate best practices regardless of the focus in the CMM. The assessment process in the department stopped before we got to define concrete improvement efforts and the research could therefore also be categorized as action case, as the intervention for my part was only small-scale.

Post interviews with the initiators in the both departments were conducted to check status in the groups that still existed after the reorganization in relation to the assessments.

1.6 Limitations

There are limitations to the research in this thesis:
  ➢ The CMM framework was only used in the initiating assessment phase of the software process improvement process, and not in a post-evaluation of implemented improvement efforts. I can therefore make no well-argued claims about measurable effects the assessment processes or the assessment results have actually have had on the organization.
  ➢ The evaluations of the methods are based on experiences from the cases in Telenor, but there are unfortunately no quantifiable measures from the cases that can be argued to weigh for or against using the methods. The improvement work was not continued directly based on the

assessment results and it therefore proved hard to measure success of the assessment evaluations, and to find strong supporting arguments to compare the assessment methods to each other.

➢ The research was conducted within one company and it is not possible to generalize the results of the research to other businesses. However, practitioners can use the results from this research as a guide when conducting CMM-based assessments elsewhere, and learn from the experiences in Telenor.

➢ Telenor decided to use the CMM because it is a well-known and established framework that can guide in a software process improvement process, and this thesis does not include a thorough evaluation of other existing frameworks' appropriateness to the company's market, structure and culture. At the end of this work I will humbly make suggestions regarding future SPI efforts in Telenor.

1.7 Structure of this thesis

The remainder of this thesis is organized as follows:

➢ **Chapter 2 – Research Method**: provides background information on the software engineering research methods used in this thesis and outlines how the research relates to the work documented in this thesis.

➢ **Chapter 3 – SPI – basic assumptions**: presents and discusses advice from professionals and practitioners regarding prerequisites for successful SPI and use of CMM.

➢ **Chapter 4 – Essence of the Capability Maturity Model**: describes the underlying software process improvement program for the CMM framework, the CMM framework structure, and more specifically CMM appraisals. The chapter also includes a section regarding the future of the CMM.

➢ **Chapter 5 – Case Descriptions**: describes in detail the conduction of CMM-based assessments in two departments in Telenor: Telenor Mobil IT and Telenor Business Communications, Information Systems and Project Management.

➢ **Chapter 6 – Experiences from CMM-based assessments**: discusses the assessment conduction processes in the two departments compared to expert advice and presents criteria for selecting a quantitative or qualitative CMM-based assessment method.

➢ **Chapter 7 – Successful SPI in an organization like Telenor:** discusses the prerequisites for successful SPI based on the experiences in Telenor, and gives some advice as to how to approach SPI and the use of CMM in such an effort for an organization like Telenor.

- ➢ **Chapter 8 – Conclusion and further work**

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2 Research Method

2.1 Introduction

In this chapter I will present the underlying philosophy for my research approach, the research methods I have used, and the specific research techniques for data collection used in the cases described in the *Case Descriptions* chapter in this thesis.

2.2 Approach

There is an underlying philosophy behind all research that the researcher uses as groundwork for her work and thereby guides the research approach. Myers and Avison (2002) categorize the different philosophical perspectives in information systems research as *interpretive*, *positivist* and *critical*. Interpretive research assumes that reality is only accessible through social constructions such as language, consciousness and shared meaning, and phenomena are only understood through the meanings that people assign to them. Positivist research focuses on the objective reality that can be described by measurable properties independent of the researcher. A critical approach assumes that reality is historically constituted and that it is produced and reproduced by people [from Myers & Avison, 2002]. Braa, Sørensen & Dahlbom (2000) introduces a new approach to Myers & Avison's (2002) categorization of research approaches by arguing that in both interpretivism and positivism the researcher is making an *intervention* despite observational efforts, and that there will therefore be unexpected outcomes. They believe that in-context investigation might involve the researcher in making an intervention in the problem situation with the aim of achieving some desirable change. The IS research framework Braa, Sørensen and Dahlbom present shows the intended research outcomes: prediction is aligned with the systematic reduction of a positivist research; understanding with an interpretive approach, and change with an interventionary approach [Braa, Sørensen & Dahlbom, 2000, p 254]. All research will have elements from the three approaches, but the degree to which the approaches are present will differ from case to case, regardless of the research method used. They also point out, that any in-context research includes some intervention as the research can not be done without some sort of interference - also pointed out by Elden & Chrisholm (1993) and Benbasat, Goldstein and Mead (1987).

In both cases there were elements of ***intervention*** because the researcher contributes to change by questioning events and applying new concepts [Braa, Sørensen & Dahlbom, 2000, p 261]. The intervention in the two conducted cases differed in the sense that one case involved more people to a relatively small degree while the other case involved less people to a larger degree. There were also elements of small-scale ***understanding*** in the evaluating phase of the conducted cases in Telenor to learn about the CMM's applicability to the departments' software practices.

2.3 Research Method

In my research I evaluate methods for conducting CMM-based assessments and CMM's applicability to a specific organization. It is important to make clear distinction between the methods used in the assessments and the research method used to evaluate these, as the goals for Telenor and for my research differ. The CMM-based assessments were conducted using a survey-based method and a qualitative approach based on interviews. The research method used to respond to my research questions is part of an action research cycle.

2.3.1 Experiment

Experiments conducted in real organizations are referred to as *field experiments.* Experiments are typically useful as theory-testing research, testing a hypothesis [Pleeger, 1995]. In my research I wanted to test which method seemed better suited in an organizational context like Telenor's and CMM's applicability in that organizational setting.

2.3.2 Case study

The clear objective in a case study is to conduct the research and the researcher acts as an *investigator* or observer rather than a participant [Benbasat, Goldstein & Mead, 1987, p 5]. Yin (1994, p 13) defines a case study as an empirical inquiry that "investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Case studies are suitable for describing the contextual factors relevant for the results [Yin,

1995], which was interesting in both cases in Telenor. There are three main categories of case studies: *hard case study, soft case study* and *action research*. A hard case study includes a mix of predictions and understanding, with statistical "generalizability" [Braa, Sørensen & Dahlbom, 2000]. A soft case study has an interpretive approach, and the intention is often to get an understanding of situations with human actors [Braa, Sørensen & Dahlbom, 2000]. The data are often qualitative and say something about the features to the investigated entities. Action research includes intervention, and the subject of the research is to introduce change into an organizational context while evaluating a certain intervention technique. The research is based on collaboration between the researcher and the organization.

2.3.3 Action research

My research method in the departments in Telenor is part of an *action research* cycle. The underlying purpose and value choice in action research is to improve the organization under study [Elden & Chrisholm, 1993, handout 5], and the action researcher is not an independent observer, but becomes a participant, and the process of change becomes the subject of the research [Benbasat, Goldstein & Mead, 1987]. "Action research embodies a strategy for studying change in an organization. This strategy consists of formulating a theory and an intervention strategy and then taking action to introduce change into the target organization" [Mathiassen, Pries-Heje, Ngwenyama, 2002, p 316, line 25-27]. The researcher is typically a participant in the implementation of a system, but simultaneously wants to evaluate a certain intervention technique [Benbasat, Goldstein & Mead, 1987].

Action research is typically a five stage cycle [Susman, 1983]:
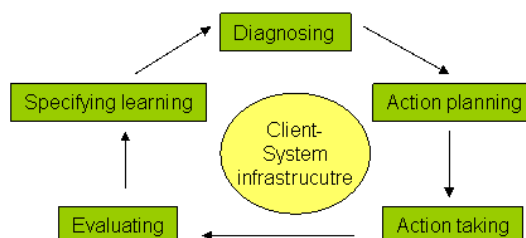
[Figure: The action research cycle [Susman, 1983]]

1. Diagnosing: The identification of the primary problems that are the underlying causes of the organization's desire for change.

2. Action planning: In this phase the researchers and practitioners collaborate and specifies organizational actions that should relieve or improve the primary problems defined in the diagnosing phase. A plan is developed that establishes the target for change and the approach to change.

3. Action taking: The implementation of the planned action. The researchers and practitioners collaborate in the active intervention into the client organization, causing certain changes to be made.

4. Evaluating: The collaborative researchers and practitioners undertake the evaluating of the outcomes. This includes a determination of whether the theoretical effects of the action were realized, and whether these effects relieved the problems.

5. Specifying learning: Evaluation lead to diagnosing the situation anew based on learning from previous activities cycle.

In both assessed departments, the idea was to iterate through an action research cycle, but the role of the researcher in the cycle was not clear for each phase, and I did not play any major part in another phases than the diagnosing phase, in addition to small-scale participation in the action planning.

Telenor Mobil IT

By initiating the assessment in the department and including all employees, one of the goals of the assessment was to change people's attitude toward the department's software processes; to increase their awareness about the way they develop and maintain software in relation to the key process areas defined at CMM level 2. In the process of evaluating the results of the assessment we also made some overall recommendations as to what process areas were in most need of improvements. However, the only part I played in the action research process in the department was the *diagnosing phase*, and did not have a significant role in the action planning phase. Also, I conducted a *post interview with the initiator to get an evaluation of the action taking phase*. The learning phase was not completed as the department was reorganized before the department got to this stage of the action research cycle.

ISPM

The case in ISPM was intended to have to same life expectancy as the Telenor Mobil IT case, but organizational circumstances beyond the scope of the CMM-based assessment in the department the assessment process was cut short. The action research cycle in this department did not live to see the completion of the *diagnosing phase* (no formal documentation was completed), and no documentation

of action planning was done. Because of this, the primary action in the case was not taken, even though this phase was planned to take place, and the department had talked about taking advantage of the researchers' (Geir Amsjø and I) knowledge about SPI and CMM in future phases of the action research cycle. I have used the data collected in the diagnosing phase to analyze the CMM's applicability to the department and to evaluate the two assessment approaches.

2.4 Data Collection Methods

The data collections methods for evaluating the two departments in Telenor's CMM level 2 maturity were questionnaire and interview.

There is several data collection methods associated with the research approaches described. The data collection techniques used in the research work related to this thesis are *document review*, *interviews* and *literature studies*.

2.4.1 Document review

In my research I evaluated the process of preparing, conducting and evaluating the results of the survey in Telenor Mobil IT, and the results of the survey to be able to state how applicable the questionnaire-based method is for rating CMM level 2 maturity of a department like Telenor Mobil IT. I also analyzed the method in comparison with the CMM-based assessment method used in ISPM to see which method seems best suited for an organization like Telenor.

The most valuable phase of the questionnaire data collection method in relation to my research was the process of registering the survey responses from the employees. This allowed me to get a complete overview of each respondent's attitude and interpretation of the questionnaire and the software processes in the department. I reviewed the documents to look for indications that showed the questions were or were not applicable to the department's practices, and to look for comments from the respondents that could support these indications, and also indicate their attitude toward the survey.

2.4.2 Interview

Interviews are the primary data source in interpretive research since it is through this method the researcher best can get a view of a person's interpretations of events and issues regarding the researched case, and of people related to the case [Walsham, 1993, p 8]. On the basis of this, the most suitable research method to be used in qualitative CMM-based assessment is interviewing. Structured interviews [Fontana & Frey, 1994] refer to "a situation in which an interviewer asks each respondent a series of pre-established questions with a limited set of response categories" [Fontana & Frey, 1994, p 3]. In an unstructured interview, the questions and answers are not defined in advance of the interview and the interviewer seeks understanding more than getting answers to specific questions [Fontana & Frey, 1994]. A common way to conduct interviews is to combine the two interviewing techniques described above into *semi-structures interviews*. In the case in ISPM I used semi-structured interviews using an interview guide consisting of CMM-related questions. The unstructured aspect of the interviews was any supplement questions I asked to get an understanding of the software process in the organization.

The goal of the interview technique used in ISPM was twofold. The interview technique was mainly used as a CMM-based assessment method, and the results were used to evaluate the ISPM department's maturity at CMM level 2.

In my research I evaluated the process of preparing and conducting the interviews to be able to state how applicable the interview questions and the interview method is for rating CMM level 2 maturity of such a department as ISPM and to compare the method with the method used in Telenor Mobil IT. The interview data allowed me to go back and examine the interviewees' interpretations of the posed questions and the software practices in the department in some detail and was therefore an important data source for my resource.

After the reorganization of Telenor I conducted post interviews with the initiators in the two departments to find identify status regarding what phase they in the action research cycle they had come to.

2.4.3 Literature study

Studying literature on relevant themes for the research forms the basis and background of the research conducted. In relation to the research work conducted in this thesis I focused the literature study on the following themes: Software Process Improvement and the Capability Maturity Model (with focus on the Capability Maturity Model for Software). The literature study sources I used are the library resource BisSys, the ACM digital library, the IEEE digital library, the Software Engineering Institute's web site, bibliographies and the Internet.

3 Successful Software Process Improvement

In this chapter I discuss recommendations made by researchers and practitioners based on theory and experiences from SPI efforts. There are several issues that need to be addressed to ensure successful SPI efforts in an organization. Most importantly is how the SPI effort is *managed* and it is important to focus attention on how the SPI effort fits in with other organizational initiatives.

SPI has become one of the dominant approaches to improve quality and productivity in software engineering. The idea behind SPI is that better software processes will lead to higher product quality and productivity in software organizations. Watts Humphrey has been a great inspiration to today's view on SPI, with his six principles of software change as a:

1. Major changes to the software process must start at the top
2. Involvement from everyone
3. Effective change requires a goal and knowledge of the current process
4. Change is continuous
5. Software process changes will not be retained without conscious effort and periodic reinforcement
6. Software process improvement requires investment

[Humphrey, 1989, p19-24]

These principles of software change lead to the following six steps for a software organization to take to improve their software capabilities - the first CMM-based method for process improvements:

1. Understand the current status of their development process or processes
2. Develop a vision of the desired process
3. Establish a list of required process improvement actions in order of priority
4. Produce a plan to accomplish the required actions
5. Commit resources to execute the plan
6. Start over at 1

[Humphrey, 1989, p 4]

Working with software needs to be looked at as a controllable, measurable and improvable process for Humphrey's six-step improvement process to give meaning. The development of the CMM was inspired by Watts Humphrey's vision of software maturity, and the authors of CMM have tried to capture this vision in the CMM models. In essence, improvement is knowledge creation. Knowledge about the organization's current practices and best-practices from the software industry (if using a model to guide the effort) creates a knowledge creation cycle in the SPI efforts:

> ➢ How do you capture and evaluate your experience?
> ➢ How do you combine them with other experiences and with your underlying theories?
> ➢ How is your thinking influenced by knowledge from outside the organization?
> ➢ What is the quality of your knowledge?
> ➢ How does your knowledge feed back into the SPI efforts?

[Mathiassen, Pries-Heje & Ngwenyama, p 7-8, 2002]

To emphasize knowledge creation in practice, the approach to SPI is evolutionary; changes should be implemented by a sequence of changes over a period of time instead of in one single, dramatic transformation. An organization should plan for continuous improvement [Mathiassen, Pries-Heje & Ngwenyama, 2002]; as some problems are solved others emerge and in that sense the SPI effort is never "done". Incremental improvements open up for possibilities to learn from experience as the SPI work moves forward, and improvement results should be visible to motivate the effort throughout the organization as the SPI evolves.

SPI initiatives can vary in scope, duration and complexity, but will typically require longer time and have higher complexity than other organizational transformation projects, like Business Process Reengineering (BPR) and Total Quality Management (TQM). A SPI effort is a long-term engagement that affects every aspect of the software production, whereas BPR is an intense and quick initiative, and TQM typically has a narrower scope than SPI initiatives. The nature of the SPI effort implies need of strong management, effective organization and planning, and good feedback and control mechanisms [Aaen, Arent, Mathiassen, Ngwenyama, 2001].

3.1 Commitment

Commitment in the organization is a necessity for successful SPI. [Humphrey, 1989, Paulk, 1999, 1996, Wiegers, 1998 & Mathiassen, Pries-Heje & Ngwenyama, 2002] Without management commitment there is a small chance that individual efforts will sustain in the organization and lead to

actual improvement, and the improvement will most likely not spread throughout organization and lead to sustainable change. Commitment to SPI means that senior management must be willing to make short-term sacrifices to free up the resources required for a long-term investment. In large organizations there must be established an alignment between senior management and one or more layers of middle managers, it is not enough that one particular level of management is committed – commitment must be present at all levels in the organization. Commitment among employees will vary, and management must be committed to building teams of individuals that are fundamentally behind improvement programs. When management states SPI commitment, most middle managers (project leaders) will show their support, even if they are not truly committed. SPI has to be prioritized by middle managers to ensure that the right amount of effort is put into the SPI program at lower levels. Management should make it clear that middle managers will be evaluated on the effectiveness of their process improvement activities as well as on the success of software projects [Wiegers, 1998], and be given tools to help them make and sustain the change. [Hefner & Tauser, 2001]

Lack of management commitment may de-motivate any grass-roots initiators and failed SPI even if management has expressed a positive attitude towards improvement efforts; talk is cheap. Real improvement requires action. As Mark Paulk puts it (1996, p 4):

> *"Bottom-up SPI, without sponsorship and coordination, leads to islands of excellence rather than predictably improved organizational capability"*

When establishing commitments to the SPI program, all affected persons should be able to give feedback to management. This is necessary to ensure equal expectations to the SPI effort and will also aid in the process of defining a measure for SPI success.

The defined necessary resources should be set aside from the start, with the opportunity to re-evaluate these as the SPI program progresses, and measurements should be reported to management along the way. To increase the likelihood of progress, the teams and departments who truly show progress in their effort to improve should be rewarded. A reward structure will increase motivation [Forsyth, 1998] for doing the work required to show progress. Incentives like more responsibility, bonuses and celebration of reaching short-term SPI goals, or other valued rewards, can motive for long-term investment in SPI efforts and ensure management commitment at all levels. Not only can rewards motivate employees and lower levels of management to strive for short-term SPI goals, but social exchange theory suggest that the power and credibility will increase when management identifies valued rewards based on resources they are in control of, and that management's promises seem credible [Forsyth, 1998]. Insight and honesty is critical: rewarding failures will breed cynicism and de-motivate employees for truly working to reach SPI goals.

3.2 Management

Resistance to change in organizations puts additional challenges on leadership of a SPI initiative. Long-term engagements in changing the way people work can be hard to accept by the affected people in the organization. It is easier and safer to do things "the way we are used to", and signaling that work processes need to be improved can be interpreted as implying that people are not doing their work well. Peoples' ways of working have typically evolved from what is considered best practice individually and some individuals with responsibility within a special area in focus for the SPI program may take the initiative as critique.

Unrealistic results expected by ambitious management will set the SPI effort up for failure. An SPI program may require excessive changes in behavior and infrastructure, which requires changes in people's attitude, and that requires time. Before initiating a SPI program, management should be educated in SPI and whatever models to be used to guide the effort to help them understand the realities of what a serious process improvement initiative will cost and what benefits they might expect.

Also, the organization should not expect that defined, repeatable procedures would make every project equal in terms of effectiveness. There is a variance in competence among employees, and organizational standards and policies cannot change that, even if everyone is following them. Organizational processes and procedures, available tools and effective team interactions will enable employees to reach their peak performance [Wiegers, 1998].

Management need to make a plan for the improvement activities. A plan supports a common understanding of goals and expectations, a mutual prioritizing of the efforts, and a plan can aid in keeping management commitment with a clear strategy towards those goals. Tracking progress against the plans is important to ensure the improvement work is headed in the right direction, as the plans are dynamic and additional actions may be identified and added as the improvement program evolves. [Hefner & Tauser, 2001, Aaen, Arent, Mathiassen & Ngwenyama, 2001 & 2002] Also when planning it is important to remember that the SPI plan should be incorporated in other plans the organization are making – SPI should happen in synergy and in relation to other changes. An SPI effort occurs in a business context and there may be other crucial business issues being worked on at the same time, and an SPI effort should be aligned with these issues (Paulk, 1996 & 1999). An organization's market and customers, funding, experience, culture towards change etc will always have impact on the SPI effort's outcome in the specific organization. Many organizations implement improvement efforts too early in the SPI effort and expect results immediately. They lack to see the complexity of cultural change; it takes time to change the way people behave. When managing a SPI effort, it is important to consider

what the best way to manage the effort is: The recommendations from professionals and practitioners are almost unison in establishing a separate organizational unit for the SPI effort, i.e. establishing a Software Engineering Process Group (SEPG) to run the SPI effort like a project. As organizations mature this becomes more and more important.

As Watts Humphrey (1989, p 287) puts it:

> *"If software process improvement isn't anybody's job, it is not surprising that it doesn't get done! If it is important enough to do, however, someone must be assigned the responsibility and given the necessary resources"*

When establishing a SEPG, it is important to have in mind that good management and systems development skills may not be the best skills for the work conducted in a SPI project. Most organizations need to train their staff before starting improvement work that gives visible results–many organizations discriminate on this [Hefner & Tauser, 2001]. However, good management skills and technical insight and experience are a good basis for learning SPI, but these are valuable assets and there are usually pressing needs for these skills for other purposes in the organization: yet another reason for establishing and SEPG – the necessary resources are allocated to the SPI effort from the beginning. Whoever is part of the SEPG, the group should be trained in basic SPI and any models or frameworks being used in the SPI effort [Dunaway & Masters, 2001], and preferably have earlier experience in using the framework, as this increases the chances of success.

There are also some risks involved in organizing the SPI effort as a project; the project must not be separated from other organizational units in such a way that it is hard to set aside the necessary resources or that the results seem irrelevant for other parts of the organization. The SEPG's success depends on the group's ability to communicate with involved persons and groups in the organization, its ability to educate the organization in SPI and whatever model being used in the effort, and its consultancy competence. A clear line of reporting can ensure the authority, legitimacy, and survival of the SPI effort in the organization at large [Aaen, Arent, Mathiassen & Ngwenyama, 2002]. Improvement activities can be treated like mini projects within the organizational SPI project, which would be a way of putting action plans for the SPI into actions. This would also give a good measure for progress.

3.3 Participation

Even if motivation for improvement is present among employees, the role of SPI in management's long-term interests may not be obvious, and this misunderstanding of what SPI can lead to may result in unintentional sabotage of the SPI effort [Hefner & Tauser, 2001]. A solution to this is participation at all affected levels in the organization. Improvement is not realistic without participation from the affected people. By including the people that will be affected by the change in the planning and implementing of the changes they are more likely to embrace the change, as the improvements and own rewards of the change might be more obvious. The employees will have control of the changes they have to cope with and feel that these changes make sense in their work. By including employees in this process, the motivation for the SPI effort might increase within the organization and the organization's culture will be reflected in the improvement process.

To sustain change and to ensure that the essential good practices are aligned with and reinforced by the infrastructure – *institutionalization*, one group in particular must be taken into consideration; middle management. Middle management can be very effective in resisting change if not convinced that the implied change is in fact an improvement. One way to achieve commitment at all management levels is through a process of interweaving goals and commitment at all management levels [Wiegers, 1998]. The SPI effort requires integrated leadership at all levels in the organization and must be consistent with the organization's business strategy and future goals to be kept alive, and this needs to be addressed at all levels in the organization so the SPI work will not get in the way of other initiatives [Mathiassen, Pries-Heje & Ngwenyama, 2002].

Another implication regarding resistance to change traces back to management commitment: if management is not committed to SPI *all* the way and the effort fails because of this, employees may be even more resistant to change in a later effort [Wiegers, 1998].

Measuring the benefits and results of the SPI is crucial for the SPI effort to go on. Feedback on progress underway (as an SPI effort may last for years) helps keeping the effort in focus, motivates and sustains interest in the SPI initiate [Hersleb, Zubrow, Goldenson, Hayes & Paulk, 1997]. Frequent assessments can be useful to track progress, and to celebrate short-term goals along the way up the maturity ladder. Measuring the effects of SPI efforts is not easy. Measuring in software engineering has been a debated issue for years, and it is difficult to establish useful metrics programs that can help measure the benefits from a business perspective. It is advisable to define relatively small indicators of success to start off, and work with the practical use of the data collected. An alternative to measuring the effects of the SPI effort is to strive for abstract goals with one of the available frameworks for SPI as a guide – for example setting CMM level 3 as the goal for a post-assessment after implementing SPI efforts.

What if SPI measurement shows no progress? The organization must be honest about the results of their improvement efforts to locate cause and interrelationships, which will make the organization able to work to improve their SPI effort, or the SPI effort will ultimately fail.

3.4 Risk management

The use of norms in SPI initiatives is a common approach for organizations to achieve improved performance. Some of the opportunities provided by using a norm in the SPI effort is pointed out by Aaen, Arent, Mathiassen & Ngwenyama (2001): A norm-based approach provides an opportunity to state a future state and vision of the improvement work, to compare and learn from other's experiences and is in that relation a useful tool in benchmarking, and finally a norm provides criteria for prioritizing improvement areas and efforts.

Problem solving is the essence of improvement [Mathiassen, Pries-Heje & Ngwenyama, 2002], and in SPI the organization's practices is the problem area – you start with the existing practices, measure strengths and weaknesses, define and prioritize improvement efforts, and you end up with improved practices. Hohmann (1997) presents a framework of the three concepts structure, process and outcome for problem solving. He emphasizes the value of the three concepts mentioned above in relation to solve a problem.
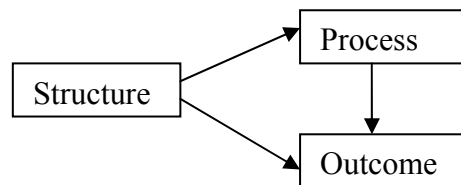
(SPO framework [Hohmann, p.29, 1997])

SPI in Hohmann's framework calls for using a norm in the SPI effort: a framework for SPI would add structure to the SPI effort, and structure defines the form and content of outcomes and prescribes and supports the processes we use to create them [Hohmann, 1997, p 15-16]. Structure in the SPI effort would be using a norm, a framework, to guide the SPI effort. Several models for improving the software process have been defined and tailored for software development, like Deming's Plan/Do/Check/Act [Deming, 1986], which the SEI developed it's IDEAL model and later the CMM frameworks based on, SPICE [Emam, Drouin & Melo, 1998], Bootstrap [Kujava & Bicego, 1994] and ISO9001, that all aims to aid in the improvement effort by helping defining necessary activities, phases and resources needed for a successful process improvement effort. In that sense, these methodologies should be used as SPI risk management tools.

However, it is important to keep focus on what is needed in the organization and not get hung up on the norm in itself. SPI programs without a pre-defined model can also be successful (for

example using GQM [Basili & Rombach, 1988], or choosing "the middle road" and use CMM as a guide in the improvement effort combined with GQM or QIP. Focus should at all times be "What is relevant for our organization, and at what level should we use the norm?" Process improvement activities should be meshed with any other improvement initiatives that are underway. Looking at industry guidelines for SPI (typically other organizations that have used one of the available models in benchmarking) can be misleading for the organization's expectations, as the uniqueness of the organization at hand is not reflected upon in these guidelines, and the range of actual performance is huge. [Aaen, Arent, Mathiassen & Ngwenyama, 2001] An assessment of the organization's current software practices should lead you to see what is working in the current software process, not just what need to be fixed, and a framework like the CMM should be implemented in accordance to the organization's culture and business environment. The CMM gives guidelines as to what is needed to mature an organization, but not how to implement the changes, and training in the CMM is important to make employees understand their role in the improvement work and contribute to decide on the implementation strategy in the organization. Training will provide the organization's members with a common vocabulary and understanding of how to assess the need for change or how to interpret specialized concepts of the improvement model being followed [Wiegers, 1998].

Moving from standardization of organizational processes to institutionalization of these requires tailoring, in the form of scaling formal processes to project size and needs.

The focus of SPI is software engineering practice. How should one focus attention on the software processes as they are practiced? The focus in SPI is on processes, and frameworks like the CMM defines a software process as a set of activities, methods, practices, and transformations that people use to develop and maintain software and the associated products [Paulk, Weber, Garcia, Chrissis & Bush, 1995]. The underlying idea in SPI is that a well defined and consistently implemented software process throughout the organization (a mature software process) will result in an increased range of expected results with respect to quality and productivity achieved by following the process. An alternative to focus on the process is to focus in discrete parts, with the risk of not getting an understanding of the interdependencies between people, methods and tools, and the product. The software process is an integrated framework that needs to be understood in an organizational context, and hence the parts can not be understood on its own, but in an integrated, holistic framework, e.g. based on processes [Aaen, Arent, Mathiassen, Ngwenyama, 2001]. The context for the software process is the environment in which it lives, and the context gives an explanation as to how and why things are being done the way they are, and represents the organization's standard software process (OSSP). Not all organizations have an OSSP, but working with SPI using the CMM framework will influence the organization in such a way that processes will gradually mature and become more repeatable. To make this happen, the defined processes have to be documented. An alternative to

focusing on the process context is to address every project as a unique process, but this would result in total dependency on specific persons (typically the heroes that are responsible for the projects' successes) to ensure success, and learning through experience across projects will be defied [Aaen, Arent, Mathiassen & Ngwenyama, 2001]. Getting an understanding of the context gives opportunities to identify best practices and sharing knowledge and experience across projects. Risks involved in the process perspective can be that competent people in the organization are set aside for internal purposes, and this may not be appreciated by customers, and existing software processes might prove hard to change. Competent people are a key ingredient in a well-functioning software process, and several methods and infrastructure frameworks have been developed to support competence building, e.g. the *People Capability Maturity Model* [Curtis, Hefley & Miller, 2001]. Competent people as defined here will appreciate and understand the process to adapt to the situation, and projects will provide opportunities to build, supplement, and transfer knowledge and routines among developers. Individuals will be participants in a learning organization where experiences contribute to the continuous development of the software process to suit contemporary and future needs [Aaen, Arent, Mathiassen & Ngwenyama, 2001]. There are risks involved in competence building too, like loss of corporate control, turf guarding where individuals or groups let personal interests obstruct organizational or project goals [Aaen, Arent, Mathiassen & Ngwenyama, 2001 & 2002].

3.5 Success criteria

The success of SPI programs in organizations depends on prerequisites regarding the organizational environment the SPI program is a part of. Management must focus attention on the characteristics of how the organization engages a complex task as SPI. Whatever methodology management decides to implement to guide the SPI effort, failure to create a prerequisite organizational character to foster success of SPI will not make the implementation deep enough rooted in the organization to be successful. Management's focus should shift from a particular methodology and toward the creation of an environment that meets the prerequisites for success regardless choice of methodology – as the characteristics of the methodology is not nearly as critical as the philosophical change required to make SPI happen. There are risks involved with addressing the different prerequisites to successful SPI that should be considered when working with SPI. Successful SPI requires balancing conflicting objectives and use of professional judgments.

The criteria for successful SPI can be summed as:

| Success Criteria	Includes issues related to
Commitment	Available resources, SPI goals aligned with business goals, realistic expectations
Management	Change perspectives, organization, training, plan, feedback
Participation	Empowerment, organizational learning, institutionalization
Risk management	Norm-based SPI

4 Essence of the Capability Maturity Model

4.1 IDEAL

IDEAL is a software process improvement program model that can be used to guide the development of a long-range, integrated plan for initiating and managing a SPI program. The IDEAL model is not developed to use with the CMM; other models can also be used to guide the SPI effort. CMM is *one* IDEAL approach to software process improvement.

The IDEAL model consists of five phases that are performed cyclically.

1. *Initiating*: The initial improvement infrastructure is established. Initial resources are made available and roles and responsibilities are assigned. A SPI plan for the three first phases of the improvement cycle is developed, and the general goal of the SPI work is defined from a business perspective. Part of the infrastructure that is established is typically a software process engineering group (SEPG) and management steering group for the SPI work.

2. *Diagnosing*: A SPI action plan is developed based on the organization's vision, strategic business plan, lessons learned from past improvement efforts, key business issues and long-term goals. It is in this phase that appraisal activities are performed to establish a baseline of the organization's current state. Results from and recommendations based on the appraisal are added to the SPI action plan.

3. *Establishing*: An improvement strategy with prioritized improvement suggestions and strategies for achieving the suggested improvements are made. Based on the general goals that were established in the initiating phase, measurable goals for what the maturity project should lead to are added to the SPI action plan. The metrics that are necessary to monitor progress are defined, and tactical action plan templates are created and made available to complete and follow.

4. *Acting*: Solutions to the improvement areas identified in the diagnosing phase are suggested. The solutions, or improvement efforts, are initiated in the organization in pilot projects to test the suggested solutions before deciding whether or not to deploy them throughout the organization. Plans for implementation and institutionalization of the improvement efforts throughout the organization are made.

5. *Leveraging*: The goal of this phase is to make the next cycle of the method more effective. Solutions have been developed, lessons learned and metrics on performance and goal achievement have been collected. Based on this, an evaluation of the strategy, methods and infrastructure used in the SPI program can be performed – and improvements in the effort can be made prior to start.
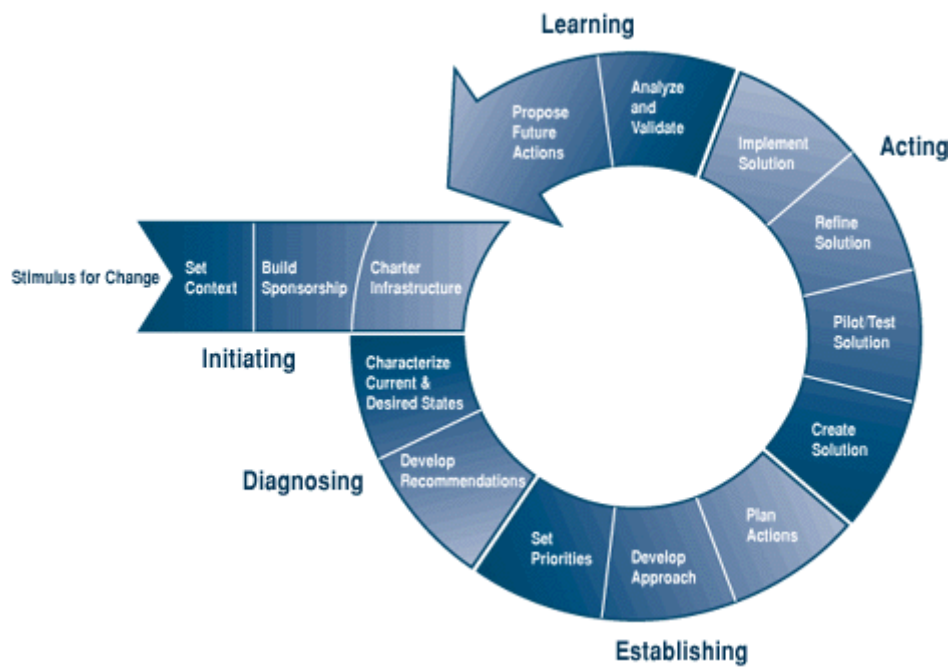
[Figure: The IDEAL model]

[McFeeley, 1996]

4.2 CMM for Software

The CMM for Software is developed by the SEI, and is a framework that describes the key elements of an effective software process. The CMM describes an evolutionary improvement path for software organizations from an ad hoc, immature process to a mature, disciplined process. This path is divided into five levels of maturity.

4.2.1 The evolution of the CMM

The background for CMM was a request from the Department of Defense in the United States as a method to evaluate their software subcontractors' capability to develop software. In 1986 the Software Engineering Institute (SEI) started developing a process maturity framework that would help organizations improve their software process. This work was assisted by the MITRE Corporation, a non-for-profit corporation combining systems engineering and information technology to address issues of critical national (American) importance. In 1987, the first maturity assessments were

conducted and a brief description of the process maturity framework and a Maturity Questionnaire (CMU/SEI-87-TR-23) was published [Zubrow, Hayes, Siegel & Goldenson, 1994] (Maturity Questionnaire later in this thesis refers to this document). The SEI intended the Maturity Questionnaire to provide a simple tool for identifying areas where an organization's software process needed improvement. Unfortunately, the questionnaire was too often regarded as "the model" rather than as a vehicle for exploring process maturity issues. In 1991, after four years of experience, the SEI published The Capability Maturity Model for Software (CMM version 1.0) in 1991. [Paulk, Curtis, Chrissis et al., 1991]. The CMM is based on actual practices, reflects the best of the state of the practice, and reflects the needs of individuals performing software process improvement and software process appraisals, is documented and is publicly available. [Paulk, Weber, Curtis & Chrissis, 1994] After extensive testing of the model in industry, knowledge acquired from software process assessments and feedback was used to produce an improved version of the model, which was published in 1993, the Capability Maturity Model for Software, version 1.1 [Paulk, Curtis, Chrissis & Weber, 1993]

Around the same as CMM version 1.1 was released, the International Organization for Standardization was working on SPICE (Software Process Improvement and Capability Determination), in collaboration with SEI, and this work has influenced later versions of the CMM. Many organizations had a desire to measure specific processes, and this required a different capability concept than that available in the CMM, which led to the release of SPICE.
Different versions of CMM have been developed, and the following CMM the SEI is involved in developing, maintaining or expanding are; Software Acquisition CMM (SA-CMM), People CMM (P-CMM), and the CMM Integrated – a product suite that is meant to replace SW-CMM, Systems Engineering CMM (SE-CMM) and Integrated Product Development CMM (IPD-CMM).

4.2.2 CMM structure

The CMM is build up by five levels of maturity, where a maturity level is a well-defined evolutionary plateau toward achieving a mature software process. Each maturity level indicate a level of process capability - which describes the range of expected results that can be achieved by following a software process, for example the predicted outcome of a software project in an organization. Each maturity level (except from level 1) is composed of several key process areas. Each key process area is organized into common features, five sections altogether. The common features contain the key practices that need to be accomplished to reach the key process area's goals [from Paulk, Weber, Garcia, Chrissis & Bush, 1993].
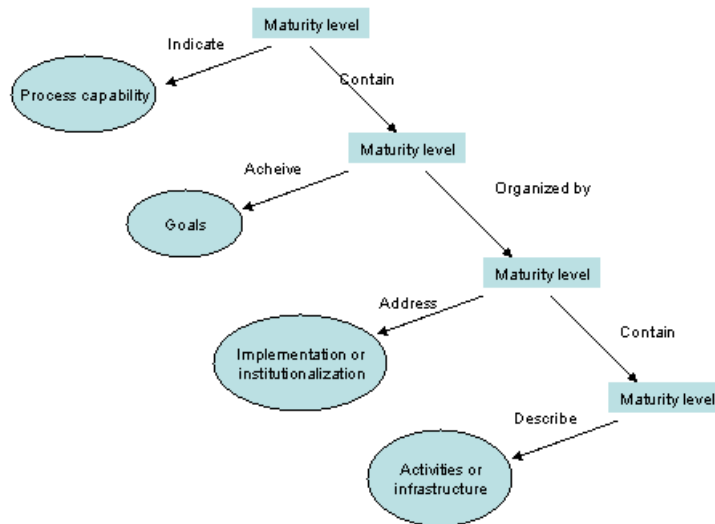
Figure: The CMM Structure

4.2.3 The maturity levels

At the **initial level** the organization has an unstable software process and unclear management practices. The process is *ad hoc* and changes as work progresses. All aspects of the process are unpredictable. At this level in the CMM, there are no key process areas. Most organizations are at this level.

At the **repeatable level**, the focus is on *project planning*, *management, tracking,* and the *implementation of procedures and policies*. The objective is to establish an effective project management process that allows the organization to "repeat" successful practices and procedures used on earlier projects. Key process areas for this level include: requirements management, software project planning; software project tracking and oversight; software subcontract management; software quality assurance; and software configuration management.

At the **defined level** focus is on *the organization's defined standard software process*, including software engineering and management processes. Activities in the software process are stable and repeatable, and implemented organization wide. Key process areas include: organization process focus, organization process definition, training programs, integrated software management, software product engineering, intergroup coordination, and peer review.

At the **managed level** focus is on *productivity* and *quality* and their assessment. Quantitative measurements of assessment and evaluation of software processes and products are done using established measurements. By this, the organization is capable of predicting quality trends within quantitative bounds. Key process areas include quantitative process management and software quality management.

The **optimization level** focuses on *continuous process improvement*. The organization has the ability to identify process weaknesses and product defects, and to improve both the process and product. Key process areas include defect prevention, technology change management, and process change management.

Optimizing (5)
– Defect prevention
– Tehcnology change management
– Process change management

Continuous process improvement

Managed (4)
– Quantitative process management
– Software quality management

Product and process quality

Defined (3)
– Organization process focus
– Organization process definition
– Training program
– Integrated software management
– Software product engineering
– Intergroup coordination
– Peer reviews

Engineering processes and organizational support

Repeatable (2)
– Requirements management
– Software project planning
– Software project tracking and oversight
– Software subcontract management
– Software quality assurance
– Software configuration management

Project management processes
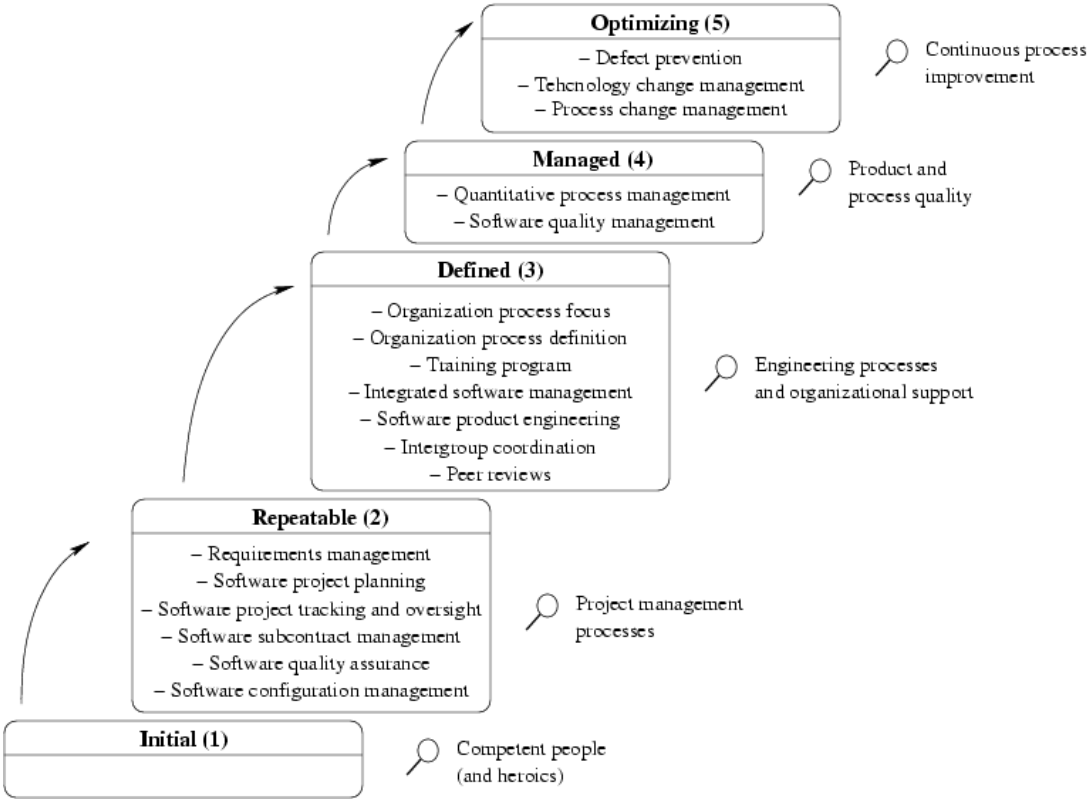
Initial (1)

Competent people (and heroics)

Figure: Key process areas by maturity level

4.2.4 Common Features

The KPAs are organized according to 5 common features that indicate whether implementation and institutionalization for a KPA are effective, repeatable and lasting. Common feature 3 describes what must be implemented to establish a process capability. Together, the other practices lay the ground for an organization's capability to institutionalize the practices in common feature 3.

1. **Commitment to perform:** This common feature describes those activities an organization performs to ensure that the process is established and will continue to be performed. This common feature typically includes establishment of organizational politics and management commitment.

2. **Ability to perform:** The preconditions that must exist to implement the software process competently. Ability to perform typically involves resources, organizational structures, and training.

3. **Activities performed:** Activities, roles and procedures that are necessary to implement the KPA. This common feature typically involves establishing plans and procedures, performing the work, tracking it, and taking corrective actions as necessary.

4. **Measurement and Analysis:** This common feature describes the basic measurement practices that are necessary to determine status related to the process, and are typically used to control and improve the process.

5. **Verifying Implementation:** Verifying Implementation describes the steps to ensure that the activities are performed in compliance with the process that has been established. This will typically encompass reviews and audits by management and software quality assurance.

[From Paulk, Weber, Curtis & Chrissis, 1994]

4.2.5 Key Process Areas

Each key process area identifies a set of activities that achieve a set of goals when addressed collectively. These goals identify what is considered important for enhancing process capability. The road to achieving the goals may differ from project to project, and also when an organization is using the CMM, it is important to tailor the model – what is important is that all goals of a key process area must be achieved for the organization to satisfy that key process area. The goals of each key process area summarize its key practices and can be used in determining whether an organization or project

has effectively implemented the key process area. The goals identify the intent, scope, and boundaries of each process area. The key process areas may be considered the requirements for achieving a maturity level and for achieving a maturity level at which all key process areas at that level, and lower levels, must be satisfied and institutionalized. [From Paulk, Weber, Curtis & Chrissis, 1994]

4.3 CMM Appraisals

Below is a graphical description of the CMM appraisal method. The first step is to (1) select a CMM-trained team of professionals in software engineering and management to do the appraisal. The next step is to (2) have the people being appraised fill out the CMM Maturity Questionnaire, which in step 3 will be analyzed to identify key process areas described in the CMM that need further elaboration that will be addressed in the on-site interviews and observations. The purpose of the (4) on-site visit is to gain an understanding of the software process followed by the site. Based on the teams' findings they (5) make a professional judgment whether or not the site/organization fulfils the key process area's goals. At the end of the visit, (6) the team creates a list of the strengths and weaknesses in the organization's software process, and these findings become the basis of recommendations for process improvement.
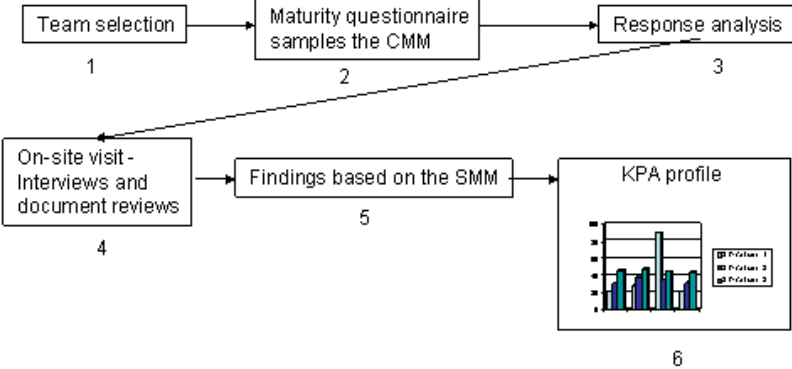
[Figure 2: A software process appraisal method based on the CMM [Carnegie Mellon University, p.82, 1994].]

4.3.1 CMM Appraisal Framework

The CMM Appraisal Framework (CAF) [Masters & Bothwell, 1995] is a framework for developing, defining, and using appraisal methods based on the SEI's CMM for Software. The CAF provides a framework for rating the process maturity of an organization against a generally, publicly owned reference model through the used of an appraisal method.

The CAF includes architecture for a generic CAF appraisal method and a description of appraisal method requirements – but how these are implemented is to be addressed in the specific method. The CAF provides a standard to evaluate a method's CAF compliance and assess the trade-offs associated with a method relative to meeting specific sponsor business and appraisal goals [From Masters & Bothwell, 1995].

The figure below gives an overview of CMM and appraisals using this method. CAF requirements give a framework for executing an appraisal using the CMM. There are several methods that are CAF compliant methods and can share common assets like tools, artifacts and techniques.
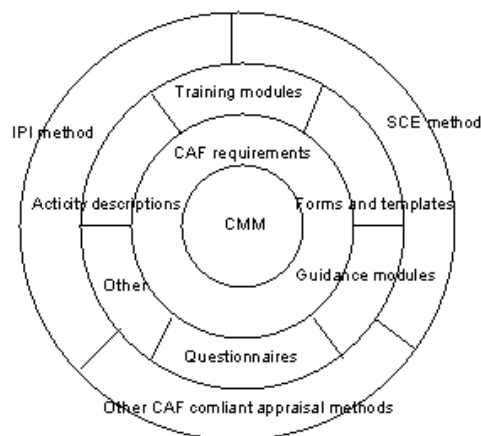

Figure: CBA Concept Diagram [Masters & Bothwell, 1995]

CMM appraisals can be assessments or evaluations:

An assessment can be used as the basis for describing the current software processes in an organization, and can be used when developing an action plan for an organization's improvement plan.

Through an assessment the organization will gain insights into the organization's software development capability by identifying strengths and weaknesses of its current processes, to relate these strengths and weaknesses to the CMM, to prioritize software improvement plans, and to focus on software improvements that are most beneficial, given its current level of maturity and the business goals - obtaining the organizational support for software process improvement [Paulk, Weber, Curtis & Chrissis, 1994 & Dunaway & Masters, 1996]. Software process assessments are performed in an open, collaborative environment, and if the goal of the assessment is to develop an action plan for software process improvement, it is important that both management and the professional staff are committed to improve their organization. The most important tool in the assessment process to understanding the organization is the structured and unstructured interviews.

A CMM evaluation is used to identify the most and capable software vendors [Paulk, Weber, Curtis & Chrissis, 1994]. The scope of an evaluation is determined relative to the need of the sponsor, who initiated the evaluation and uses the results to make decisions about the organization's future business. [Dunaway & Masters, 1996] Software Capability Evaluations (SCEs) are SEI-developed CMM evaluations methods used for software acquisition as a discriminator to select suppliers, for monitoring and for incentives.

The appraisal methods used in this thesis are *CMM-based assessments*.

4.3.2 The CMM-Based Appraisal for Internal Process Improvement method

The CMM-Based Appraisal for Internal Process Improvement (CBA IPI) [Dunaway & Masters, 2001]method is an assessment of an organization's software process capability by a trained group of professionals who work as a team to generate findings and to rate the organization at the CMM scale based on the fulfillment of key process areas within the assessment scope. Data are collected from questionnaires, document reviews, presentations, and in-depth interviews with middle managers, project leaders and software practitioners.

The goals of the CBA IPI are:

1. To support, enable, and encourage an organization's commitment to software process improvement
2. To provide an accurate picture of the strengths and weaknesses of the organization's current software process, using the CMM as a reference model, and to identify key process areas for improvement.

The CBA IPI is indented to establish consistency between assessments so results from one assessment can be compared to those of another. The CBA IPI complies with the CAF, so results from a CBA IPI are intended to be consistent with results from other CAF compliant methods.

The approach of the CBA IPI is to have an assessment team assembled and trained in CMM and the method and conducts a series of activities with key people in the organization to understand their problems and suggestions for improvement. This should be done under the leadership if a Lead Assessor. Lead Assessors are trained and certificated at SEI.

The method is based on the following key assessment principles:

➢ The Maturity Model for Software v1.1 is used a process reference model
➢ A formalized assessment process that complies with the CAF is used
➢ Senior management is involved as the assessment sponsor
➢ The assessment is based on the sponsor's business goals and needs
➢ Observe strict confidentiality by guaranteeing that no information will be attributes to an individual or project
➢ The assessment approach should be collaboration between the assessment team and the organizational participants.

The CBA IPI method defines a set of minimum requirements for a method to be considered a CBA IPI. These requirements concern the assessment team, assessment plan, data collection, and data validation, rating and reporting of assessment results.

[From Dunaway & Masters (2001)]

4.4 CMM Integration

The Capability Maturity Model Integration (CMMI) intends to provide a CMM that covers product and service development and maintenance but also provides and extensible so that new bodies of knowledge can be added [Chrissis, Konrad & Shrum, 2003]. The CMMI, in its present form, is a collection of best practices for the "development and maintenance" of both "products and services." The model was developed by integrating practices from four different CMMs - the "source models:" the CMM for software (SW-CMM), for systems engineering (SE-CMM), for integrated product development (IPD-CMM), and for acquisition (SA-CMM).

The CMMI intends to sort out the problem of using multiple CMMs. Many organizations have expressed a need for improving their processes across the organization's disciplines, and using different CMM models at the same time have proved difficult to master. The combination of these models into a single improvement framework was intended for use by organizations in their pursuit of enterprise-wide process improvement [Chrissis, Konrad & Shrum, 2003].

4.4.1 SCAMPI

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) [SEI, 2001] is based on the same principles as for a CBA IPI. The SCAMPI is compliant with the Assessment Requirements for CMMI (ARC) [SEI, 2001]. The SCAMPI is designed to provide benchmark quality ratings relative to Capability Maturity Model Integration models. It is applicable to a wide range of appraisal usage modes, including both internal process improvement and external capability determinations. The use of SCAMPI is growing as organizations become more familiar with the CMM Integrated.

5 Case Descriptions

5.1 Telenor Mobil IT

5.1.1 Background

The summer of 2003 the IT department in Telenor Mobil performed a maturity assessment of the departments' software processes in accordance with the CMM.

An employee in the IT department, a researcher from the company's research department and I conducted the assessment work. The researcher from the company was project leader for Telenor's Research and Development Department's efforts in IT systems and had an ambition to establish increased knowledge about Telenor's maturity in the field of Information Systems and about the need for efforts in SPI. The choice of using CMM as a framework for assessing the department's software process maturity was based upon the researcher's knowledge about researchers at Aalborg University that had developed a tool for conducting easy and quick CMM-based maturity assessments, the Flexible Assessment Questionnaire Tool [Kristensen, 1998a] (FAQT from here), and it seemed beneficial to take use of this tool. The employee in the IT department in Telenor Mobil was responsible for IS methodology in the department, and had earlier been in contact with the researcher through other projects and knew of the CMM from earlier work.

5.1.2 Choice of method

Telenor Mobil IT decided to use one of the tools developed at Aalborg University [Kristensen, 1998b] because this seemed like a cheap and quick way to conduct an assessment, as someone had already developed a tool that fit our use.

We had some acquaintance to the FAQT, and we also had contacts at Aalborg University that assisted with guidance and experience with use of the tool. The FAQT is well documented, and after analyzing what it contains and how it works we decided to use it in a maturity assessment in the department.

We decided to prioritize aspects like costs, time and practical aspects regarding the conduction instead of a closer evaluation of how Telenor Mobil IT best could conduct a maturity assessment. Normally, methods like observation and interviewing would provide a deeper understanding of the situation than a questionnaire, as the communication between the researchers, who should know the CMM well, and the employees, who know the organization, would be richer. When the organization is familiar with the CMM terminology and purpose, it might be sufficient to use a questionnaire – this might be the case in an organization that has worked with CMM a while and conducts an assessment to measure progress. The risk of choosing to use a questionnaire in an inexperienced organization with CMM and SPI in general is that the respondents do not understand the purpose of the assessment or the questionnaire and leave out information that might be relevant for a maturity profile – this risk is even higher if the awareness phase in advance of the assessment is not thorough. As we went through the responses from the respondents, we saw that this was also the case in Telenor Mobil IT: Several respondents rejected the questionnaire (chose not to respond at all) because they perceived it as irrelevant, even though we had explained (in the introduction to the questionnaire) that some of the chapters in the questionnaire (KPAs) are relevant for *all groups in the department*, while some chapters may only be relevant for some groups. Also, the difference in responding "I do not know" and "Not relevant" is very important for the result analysis even if the difference does not seem significant for the respondent: When the employees do not know what is practiced in the department it might say something about the department's maturity, but aspects of the department's practices that are not relevant does not; they say more about how well the questions in the questionnaire fit the software practices in the department.

The FAQT is developed in Microsoft Access and requires some knowledge about the software, but we evaluated the FAQT to be beneficial to use, as the necessary knowledge about MS Access could be acquired without too much difficulty. The contents of the FAQT, the questions in the questionnaire and the calculations behind the fulfillment of goals, are based on CMM's recommendations at maturity level 2, and the tool follows the CMM quite strictly in the sense that the statements are more or less directly based on questions from the Maturity Questionnaire. The maturity profile that is generated by the FAQT is only aimed at how well the organization fulfils KPAs at CMM level 2, and that seemed to fit the IT department quite well as there had not been conducted any maturity profiles earlier and the CMM requires achievement of all KPAs at one level before moving up to a higher level in a consecutive order.

5.1.3 Assessment goals

The IT department had not defined any specific short term goals for conducting the CMM-based assessment, but an abstract goal with the work was to find in what areas in the software processes improvements seemed to be most pressing to get a baseline for initiating improvement work in the department. The department had planned to do a CMM level 2-based assessment the summer of 2004 to see if improvements had been achieved, but the organization was reorganized and the department did not exist in the same form as when the first assessment was conducted and a post-assessment could therefore not be conducted in the department. For the representative from the department, an abstract goal of the assessment results was to find data that would support his opinion about where improvements had to be made in the way the department worked with software, and to increase awareness about how the department work with software.

5.1.4 Launching

The original version of the FAQT was developed in Microsoft Access 97, while the only version of Microsoft Access we had available was Microsoft Access 2000. This required a conversion of the original tool, and we experienced small difficulties with the tool when creating reports that might be caused by this conversion (the conversion process is automated in Microsoft Access 2000). For more details on adjustments being made see chapter 6.3 or *"Assessing software capability maturity in Telenor Mobil. Practical Experiences"* [Sveen, Sørgaard & Torgersen, 2003].

In advance of the assessment, management in the IT department had decided that everyone in the department should participate. We believe that this was the reason for the high response rate, and this decision by management was also a signal to the organization that there was a wish to identify improvement areas in the department's software process to launch improvement efforts at a later stage. Participation from the employees is very important, both in the phase of identifying improvement efforts, and in the phase of implementing the efforts. By including all employees in the maturity assessment the awareness and knowledge about SPI, maturity assessments and CMM increases in the organization as a whole - as the awareness about the software process that exists in the department increases, which in itself can lead to improvement.

Before the survey was conducted, we had the questionnaire tested by three different persons from different groups in the department, and in different roles. We wanted to get feedback on the experience of filling out the form, about things that were unclear in the guidance text and the questions, how much time it took and general advice on how we could make the questionnaire better. The response from the test persons differed some, probably due to role and which team they were part of, but we

considered their comments and adjusted the questionnaire accordingly while we kept in mind possible reasons for the original formulation in the questionnaire.
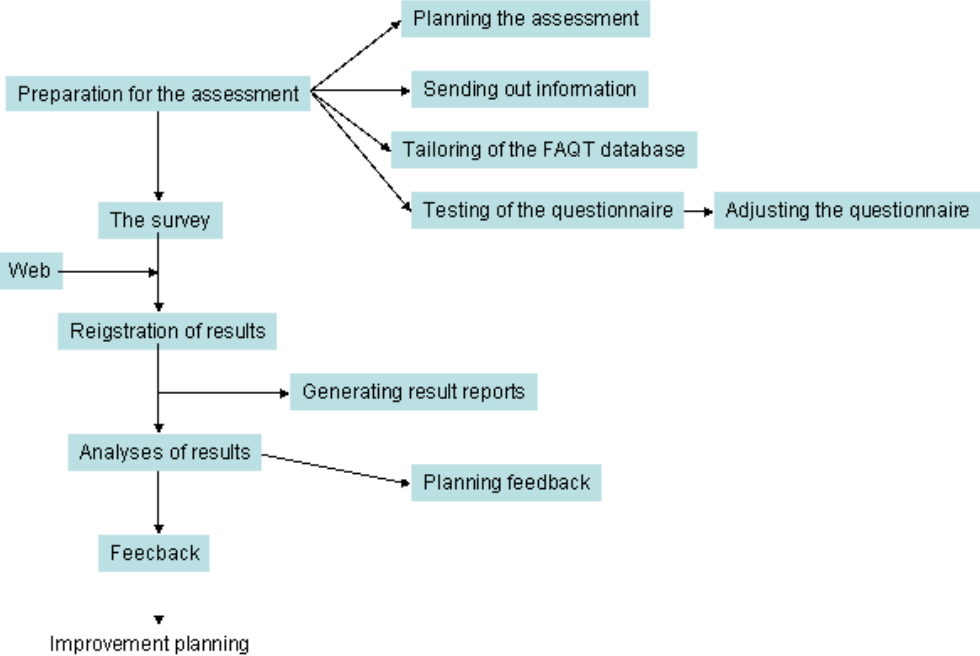
5.1.5 The assessment

In advance of the assessment, the team leaders had been given the responsibility to hand out the questionnaires and collect them again and give to the appraisal team when they were filled out. The team leaders in the department were also told to brief their team about the assessment, but this was done in varying degree, probably due to a very strict time frame for handing out and collecting the questionnaires. The team leaders had one week to hand out the form to their team members and deliver the responses.

In the introduction to the questionnaire we explained that the respondents would be held anonymous and that only appraisal team members had access to the forms. However, the database requires a name for each respondent to work properly and we therefore had to ask respondents to fill out their name and employee number. We also found it useful to ask for their telephone number so we could get in contact with any respondent if the questionnaire was not filled out properly or we had questions about the completed form. It took the respondents approximately 60 minutes to fill in the whole form.

The registration of the completed forms started as soon as the questionnaires came back from the team leaders. The extent to which the questionnaires were filled out varied and it took everything from 7 to 45 minutes to register a response in the database. The questionnaire is built so that the respondents have an opportunity to make additional comments to each question and each chapter (KPA), and we found these comments very interesting and important. In total, about 86% of the filled in forms were registered manually while the rest was registered in a web based version of the questionnaire.

We had in advance of the assessment discussed the option of making a web based version of the questionnaire but due to strict time frames we decided to use the FAQT as it was. There was also some resistance within the appraisal team to use a web based version of the questionnaire because any comments referring to earlier questions made by the respondents will be lost when registering directly into the database (as the respondents are anonymous in the database and it is not possible to recreate a filled in questionnaire after registering). However, as the deadline for delivering in the filled in forms approached, a web based version that was connected to the database was developed based on a tool that had been used in earlier questionnaire based assessments and the employees that had not yet filled in the form were asked to do so using the web based version.

We received signals from the respondents that they preferred a web based version, and we believe that this solution caused a higher response rate. The web based version also limited the work of interpreting and registering filled in questionnaires. However, Arent & Iversen (1996) and Kristensen (1998b) recommends that the registration is done by the appraisal team, as this process gives sight into the responses that are useful for interpreting and analyzing the data as a next step in the assessment work. This was particularly important for my research as I wanted to learn about the process of conducting a CMM-based assessment using the FAQT. Using a web based version makes it harder for the appraisal team to track references to earlier questions, while manual registration allows for going back to earlier responses, and to reformulate comments so they give meaning independent of earlier questions or comments.

(The assessment process in Telenor Mobil IT)

5.1.6 Aftermath

As the registration work came to an end, we had to generate data reports for analyzing. In the FAQT, several reports were already made, but we found it useful to make some modifications.

While registering the filled in forms we had noticed that there was a certain connection between the respondent's role in a project or a team and her response, and we therefore decided to add diagrams in the data reports that showed this connection.

The complete data report is meant to be confidential and only accessible for the appraisal team and top management. We found some of the comments made useful to highlight the situation in the department and decided to use them in the final reports. However, to be sure we kept the respondents anonymous we went through the comments and decided whether or not it was necessary to reformulate the words so the quotes were not traceable back to a specific employee. The filled in forms were maculated as the database was updated so the traceability back to a respondent is lost.

The complete standard report from the FAQT is available for the IT management team in Telenor Mobil. The results were also presented to the different management teams in the different teams in the IT department.

Based on the results from the assessment, the participant in the appraisal team from the department made a few improvement suggestions that were initiated within the department through other work related to software process methodology. The plan was for the department to undergo a new assessment the summer of 2004 to measure the effects of the improvement efforts, but as the unit was reorganized this plan was cancelled.

5.1.7 Outcome/The results

We had limited experience in evaluating the results from a questionnaire-based CMM assessment. The FAQT generates a large standard report that calculates fulfillment percentage for each KPA, both accumulated and from demographical variables as team, work task etc. The report also lists the distribution of the answers for every question and comments from the respondents. We found it challenging to decide how this data should be interpreted, and in reality we would never achieve a 100% fulfillment because there is a variation in how the respondents interpret the questions, and also to the degree they are capable in answering the questions, as some questions may not have the same relevance for all employees. There is nowhere in the tool or in the guidance documents that it is explained how many percent is needed to conclude that a certain KPA is achieved. However, this information is available in the master thesis by the two persons who developed the FAQT [Arent and Iversen, 1996]. Arent and Iversen (1996) point out that there is no way to decide whether or not an

organization is on CMM level 2 from the KPA profiles that are produced by generating reports in the FAQT, but it is not relevant to discuss whether the organization is a level 2 organization with scores below 70% [Arent & Iversen, 1996]. We decided to use the percentages to look for specific challenging areas for the department, and to look at the "bigger picture" of how the software processes in the department are practiced.

In our analysis of the generated reports we looked at:

> The variation in fulfillment degree between the different KPAs
> The variation in fulfillment degree between the different teams and project types in the department
> The variation between the different questions related to the same KPA with specific weight on questions with low score
> The textual comments from the respondents.
> Patterns in the variation, especially patterns that were connected to the textual comments.

We also had a dialog with associate professor Peter Axel Nielsen at Aalborg University regarding the interpretation of the responses and to compare some results with similar numbers from assessments done in Denmark. His comments were that it is normal for an organization that has not focused on CMM before to score relatively low on the different KPAs.

When looking at the result reports from the FAQT there were no KPAs that immediately stood out with especially high or low fulfillment percent compared to the others. The larger variations may be at the project level, and a few project participants contribute with heroic efforts within one project, and this may not be obvious in the results for the department as a whole. This immediate analysis forced us to look deeper into the results to try finding information that would help us planning further work in the SPI effort.

We started to look for patterns in the results. For each KPA the fulfillment of questions related to measurement and verification of practices was low. The results showed that there were some good practices related to this in the department, but there was a lack of formalized processes and discipline in relation to the use of the processes that were defined. The textual comments from the respondents were very useful in that respect; they gave us useful information about actual practice versus organizational policy and standards.

The FAQT generates graphs showing fulfillment percent for each KPA based on demographical data like project type, group and the role in the project the respondent has. When looking into these graphs, we could see that the maintenance department stood out. The fulfillment percent for the questions and

goals for each KPA for the maintenance department was lower than for all the other groups and we looked into the different questions to find the reason for this. Some of the KPAs at CMM level 2 are not necessarily as relevant for a maintenance department as for development projects, and that could explain the low score for the KPAs Requirements Specifications, Project Planning, and Project Tracking and Oversight. The low score on the second half of the questionnaire; Software Quality Assurance, Software Configuration Management and Software Subcontract Management, however, are not easily explained with irrelevance. These last three KPAs are just as relevant for software maintenance work as for software development, but since the questions related to this is located last in the questionnaire, a lot of the respondents oversaw them, as a first glance at the questionnaire (questions from Requirements Specifications) were perceived irrelevant and they probably judged the rest of the questionnaire as irrelevant as well. Even those employees in the maintenance department that read through the whole questionnaire expressed a negative attitude towards to the complete questionnaire, and this might have contributed to the low results for the group.

For the department as a whole, the KPA with lowest score was Subcontract Software Management, but at the time this was not evaluated as the most pressing KPA to work on. There were other efforts planned in the department that were linked to the results from the assessment, and those KPAs that were most relevant to those plans were acted upon.

The assessment results showed that there was a lot of good practice in the department, but most of it is not formalized in any way. Informal culture may work for small projects, but decreases the ability to follow through large projects, and there seemed to be a lack of reuse of experience across projects. Other improvement areas were management tracking and focus on project deliveries compared to expectations.

Note: Interestingly enough, the respondents that spent the least time to respond to the questionnaire were also the most negative towards the questionnaire. This is the opposite of what Arent and Iversen (1996) experienced in their study. Arent and Iversen does not seem to give any explanation to this, but in Telenor Mobil IT many respondents found some of the KPAs addressed in the questionnaire irrelevant for their daily work and did not read every question for these KPAs but made a note in the beginning of the chapter about irrelevance.

5.2 Telenor Business Communication, Information Systems and Project Management

5.2.1 Background

A committed person in the ISPM department that was eager to put attention to the department's development processes to create improvements initiated the work with the CMM-based assessment, and the manager of the department approved the initiative. The initiator had been in contact with the researcher from the organization's Research and Development department from the case in Telenor Mobil IT in relation to other projects and contacted him for advice before the CMM-work was started.

The goal of the CMM-based assessment was to identify "best practices" in the department and transfer these to the other groups within the department. The choice of using CMM in this work was based on acquaintance with the model framework, and no other method or framework was really up for consideration. The initiators liked the stepwise infrastructure in the CMM and decided that this would be a good model for seeking out best practices to transfer across the groups in the department. The initiator and the management in the department agreed that the KPAs at CMM level 2 were important aspects of the software process that was worth to aim for.

The department consisted of approximately 30 people working on about 20 different systems. The customers are mainly internal to the organization, with their own customers, and not customers that represent one or more of the user groups. The department is further divided into groups that are responsible for the different systems.

5.2.2 Choice of method

The assessment in the ISPM department was performed qualitatively instead of using the FAQT as in Telenor Mobil IT. This choice was made after assessing benefits and risks with using a quantitative method from our experience from Telenor Mobil IT. The ISPM department worked with almost as many systems as there were employees (about 2 to 3), and there were some teams in the department that were so unique that it would require in-depth research to understand their work processes. The department's milieu was very heterogeneous and the FAQT tool would not capture this. One of the teams was rumored to be very efficient and deliver a high quality product, and we were interested in finding out if this was true and possible reasons for this. We realized that having the employees crossing off answers to questions taken directly from the CMM would not give us the insight and understanding required to pinpoint why the team was so good at what they were doing, while a method based on interviews and conversations would.

The team that initiated the assessment work was already familiar with CMM and the KPAs at level 2 (and a few at level 3) seemed appropriate for the department to aim for, and other CMM models like the CMMI was not considered an option.

5.2.3 Launching

Before the interviewing round started, we decided to have a meeting for the whole department where we presented the assessment plan and the CMM. The goal of the meeting was to educate the participants in CMM maturity assessments, and to motivate them for the SPI effort. The internal initiator presented the work to be done and abstract goals, and Geir Amsjø presented software process improvement and CMM with room for questions and comments. Feedback from the employees showed a lack of understanding of how best practices from one group could be transferred to another, as the systems had very different functions and customer-relations. We hoped that the assessment would give some answers to this as well as seeking out best practices.

We decided that interviewing about half or less of the employees in the department would give us enough data to describe the software processes in the department and to say something about the fulfillment of goals related to CMM level 2. In selecting interview objects we chose employees from different teams that were suspected to have a good understanding of the software processes, and some team leaders that would need to have a deep understanding of the software processes. The initiator from the department worked as a coordinator setting up interviews and involving management and employees in the effort. We decided to evaluate the questions in the interview guide to see how well the questions gave us the answers we needed about half way through the interviewing process so we could make adjustments if the questions seemed inappropriate for the practices in the department.

Based on earlier experiences from software assessment work we decided to use the Maturity Questionnaire as an interview guide. The questions in the interview guide were based on KPAs related to CMM level 2 (and 3, but we focused on the ones for level 2) and more abstract than the questions in the FAQT.

5.2.4 Assessment goals

As an abstract goal for the assessment work, our contact in the department wanted to be able to give hints to management and employees what practices seemed to be working well and what areas in the software processes that needed improvement. The challenge was to develop universal methods and practices for the department, across the different systems, and the initiator in the department thought that a CMM-based assessment could give directions to where the department needed to work with their methods in software development and maintenance. The goal for the assessment was to seek out best practices in the department as a whole, and also find what areas in the software process were most suitable for standardization in the department.

5.2.5 The assessment

My adviser at Department for informatics at the University of Oslo, Geir Amsjø, and I conducted the interviews. Geir Amsjø conducted a couple of interviews with employees in the department, and I observed the situation and was ready to assist if I felt there were issues that were not covered or elaboration was needed (this did not happen). The reason he conducted the first interviews is that he had experience in this kind of interviewing and knew the questionnaire very well – well enough to ask supplementary questions when he felt that he did not get a good enough answer from the questions in the questionnaire. We also wanted to test the questionnaire as to how appropriate it seemed to be to the participants' work tasks, and decided that he would be a valuable asset in that respect because of his experience in SPI and software engineering in general. The interviewees were team leaders, sub team leaders and developers in the department. The different groups of stakeholders experience different problems and had different opinions on what seemed to be working well and what seemed to be not working in the department's software processes. After a couple of interviews were conducted, we felt that I was familiar enough with the interviewing process and the questionnaire to conduct the remaining interviews on my own or with assistance from my adviser.

In advance of the interviews I had translated the questionnaire into Norwegian because I felt this was a good way of getting a deeper understanding of the questions, and also because the language and sentences in the questionnaire can be perceived as unnecessary detailed and demanding to read.

During the assessment process in the department we found that there was a need for further adjustments to be made to the questionnaire for the assessment to best uncover the work practices in the department. There were questions that were obsolete, not specific enough, or there were aspects of the work practices that were not captured by the responses to the questions in the questionnaire. Some terms do not seem to be relevant to the situation in the department, and a few important aspects of

maintenance are not covered at all at CMM level 2. Organizations that have existed some years will often have a mix of development and maintenance work when dealing with software. Because of this, alternative models to CMM have arisen and inspiration from these was used to develop a new questionnaire. The new interview guide was based on discussions on experiences from earlier interviews between my adviser and me, and new interviews were conducted based on this. The new interview guide was developed based on the original interview guide, initiatives like ITSCMM [Niessink, 2004] and ITIL [OGC, 2003 & BC Associates WF, 2004]. ITIL focuses on process areas more related to maintenance than development:

> Incident Management
> Problem Management
> Change Management
> Release Management and
> Configuration Management

These process areas are more applicable for an internal software department and maintenance work than the CMM's KPAs at level 2.

After the tailoring of the new interview guide was completed, we performed a second round of interviews, now with focus on the maintenance work performed in the department. We also selected some additional respondents to represent some of the projects that were already represented to get a wider perspective on each project.
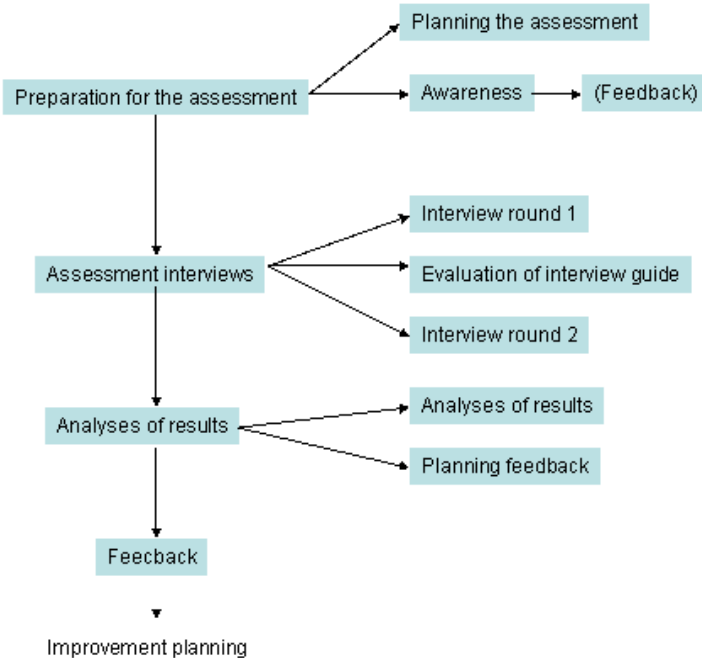
5.2.6 Aftermath

As the interviewing process proceeded, data from the interviews were registered and distributed to the rest of the appraisal team. Each team member made comments or suggestions for improvements in the interview guide based on our experiences for future use. The plan was to make a summary report with the results of the assessment and an experience report, but due to relatively unexpected and dramatic organizational changes the SPI work in ISPM came to an unexpected halt as the unit was reorganized and the department shut down. The different groups in the department exist for the most part as before, but the department does not exist anymore and the groups are moved to different parts of the organization.

We had a closing meeting at the end of the interviewing process where we analyzed the data from the interviews and discussed the findings, but this was only documented shortly in a working paper and no clear conclusions were made. The only documentation on the work done in the department is this thesis.

5.2.7 Outcome/the Future

As the department ceased to exist before the results were documented no improvement efforts were initiated, and there are no concrete plans to implement improvement efforts in the reorganized organization directly based on the assessment done in the ISPM department. However, the awareness about the organization's software processes has increased, and one of the KPAs that clearly stood out as a pressing improvement area has been focused on, also after the reorganization.

The results from interview round number two clearly showed that there is a big difference in the maintenance work and project work in the department. Most of this work is differentiated into separate groups in the department, but employees in some groups also have to separate their time into maintenance and project work, and the way the employees perform the different tasks vary from type of work they do.

All over, there seemed to be lack of routines and standards for how things are to be done in the department, but the interviews revealed a lot of good practice that are not institutionalized, and the

challenge for the groups that still exists after the reorganization of the unit is to transfer this good practice to groups, or projects, that do similar work.

The fulfillment of each KPA should not necessarily guide the further improvement work in an organization, because the CMM should first of all be tailored to a business situation, and when analyzing the results of an assessment issues like customer needs and market situation should be considered [Paulk, Curtis, Chrissis & Weber, 1993, Paulk, Weber, Curtis & Chrissis, 1994 & Paulk, 1999]. The business needs for process improvement drive the requirements for an assessment [Dunaway & Masters, 1996]. Telenor is in a position where the company is looking at the opportunity of outsourcing, and in that relation the results from the Software Subcontract Management KPA at CMM level 2 are relevant even after the reorganization. The most valuable findings here relevant to the new organization is that there seems to a lack of routines and standards for this type of work, and in the new organization, where outsourcing seems to be a focus area for management, this is an area that clearly needs improvement.

Plans are made to conduct a new assessment in the new organization, but as of today this work is postponed (most likely sometime in January 2005). The official reason for the postponement is that there are so many other surveys being done in the organization at the time and management does not want to inflict one more survey on the employees. However, there are an additional number of possible reasons for the postponement:

➢ The plans only include an assessment, no measurement program that would indicate progress – and no defined SPI plans for the future; no defined goals for the assessment work.

➢ Reluctance to conducting another assessment based on earlier experiences: What if a new reorganization is at hand – what is the value of assessment results if that happens?

➢ There seems to be lack of management commitment, even if management's awareness on the importance of SPI work is increasing there is no budget for this kind of work.

6 Analysis of assessment methods

6.1 Need for tailoring

Although the CMM is widely adopted in the software industry, there are misunderstandings on how to use the framework effectively. The Software Capability Maturity Model (CMM) [Paulk, Weber, Curtis & Chrissis, 1994] was originally developed for use by organizations on large government contracts, and this is reflected in the expressions in the key practices of the CMM, but the model was written to be tailored to be used in other settings as well [Ginsberg & Quinn, 1995, Paulk, 1999]. There is a significant population of software-producing and -acquiring organizations operating in different environments, for which the key practices require significant interpretation and tailoring prior to application in order to apply the key practices in their specific environment [Ginsberg & Quinn, 1995]. This tailoring is necessary for the CMM to aid in a business' process improvement effort and capability evaluations.

SEI has published reports concerning how to tailor the CMM - one of them presenting a tailoring framework that identifies process artifacts, tailoring processes, and their relationships to project artifacts [Ginsberg & Quinn, 1995]. The report also explores the nature of various kinds of tailoring used in the definition and development of software process descriptions [Ginsberg & Quinn, 1995]. Techniques appropriate to each type of tailoring are then discussed. The general approach utilizes and builds upon the Software Process Framework (SPF), whose purpose is to provide guidance for designing, analyzing, and reviewing software processes for consistency with the CMM (in a checklist format etc). In the tailoring framework, which was published in 1995, the writers claim that it is essential that a set of tailoring techniques are used to ensure that the CMM is used "correctly," where the tailored organizational version is consistent with the intent of the CMM. However, the amount of supporting material for using the framework is huge. *Supporting material* implies that practitioners would find the information supporting, but identifying what you need in a specific situation in all the available documents and papers is a challenge. SEI has published a lot of this material on their web site [http://www.sei.cmu/edu], in addition to complete books on supporting CMM implementation, but it is a very time-consuming and stressful task to locate what you need. Some of the critiques against CMM [Bach, 1994, Jones 1995] are based on the structure and content of the CMM framework. As a response to this critique, more general advice on using the CMM has been published. [Paulk, 1996 & 1999, Bamberger, 1997]

6.1.1 Tailoring guidelines

The business needs of the organization must be the driving force for using the CMM: The organization's desire should be to improve, with a direct tie to business goals, and the drive for using the CMM will typically be:

- Decreased costs
- Increased quality
- Better schedule performance
- Continuously improved software processes

When using the CMM in an organization, the business goals of the organization must be known to tailor the CMM to the organizational context, and the business goals should always be the main concern when tailoring the CMM [Ginsberg & Quinn, 1995, Paulk, 1999].

The key practices and examples in the CMM give a description of what are considered to be good software and management practices, but does not give a solution for implementation of these practices. The key practices are not requirements, but are intended to be generally applicable [Paulk, 1999], and are *one* possible way of reaching the goals of the key practices. It is the end states for each key practice that should guide the improvement efforts, and not the 316 described practices that should be followed – *but informed, reasonable, and professional judgments about each key practice and its associated goals has to be made.* [Paulk, 1999, p 3] This sort of tailoring is referred to as *tailoring by degree*; an activity, a work product or a process artifact needs only to be changed in a minor way to meet its goal. These minor changes are done to the object's attributes, which can be

- ❖ *Formality*: activities may for example be performed with varying degree of detail
- ❖ *Frequency*: what seems reasonable for the organization (for example even-driven or regularly)?
- ❖ *Granularity*: the level of detail in the process definition and
- ❖ *Scope*: what activities seem irrelevant? There are several dimensions of scope that are relevant; both in terms of organizational involvement and investment, and in terms of CMM scope: what are relevant for the organization's goals?

Before applying the CMM in a business context, the organization needs to *determine similarities and differences between the terminology in CMM and the organization's environment*. The result of this

analysis will help the organization define their work practices, which is a starting point to find areas that need improvement and what activities or routines that might be worth transferring to other areas or projects in the organization. When looking at the terminology used in the CMM, the organization needs to look at the following terms in particular [from Ginsberg & Quinn, 1995, Paulk, 1999]:

➢ *Organizational structure:*
   The organization's structure may differ from the assumed structure in the CMM, and if so, the key practices that in the CMM ask for a specific role or group to conduct a specific task have to be adjusted, mapped or correlated to the actual structure of the organization. This tailoring may very well have to made, as the CMM assumes a rather large organization with well-defined roles developing and maintaining large systems. Organizational structure includes groups within the organization with specific responsibilities independent of other projects in the organization at the time – like a quality assurance group, a subcontract management group or a group responsible for configuration management across the organization. The roles defined in the CMM may not suit the role definitions in the organization, but the important thing to keep in mind the *responsibilities* within the organization, not the names of the roles.

➢ *Customer and end-user relationships and requirements:*
   What about the customer relations? The CMM reflects the large, aerospace, contract software development environment it was originally intended to address, but most software organizations today have more complicated customer relations. The contract environment assumes a single known customer who specifies requirements [Ginsberg & Quinn, 1995], but requirements may come from different customers, often in the same organization. These relations may be difficult to put into a CMM context, and the overall advice here is to use "common sense": make professional and reflected judgments [Ginsberg & Quinn, 1995 and Paulk, 1996, 1999].

➢ *CMM maturity level:*
   The organization's process capability will affect the tailoring process, and the organization should focus on the goals of the maturity level it aims to achieve.

I will explain this in more detail regarding CMM level 2, where focus is on managing software projects, and this is the level against which both departments in Telenor decided to assess themselves. A lot of the practices at this level concerns organizational structure – the establishment of groups with different responsibilities, but focus should be on responsibility and the KPA goals [Paulk, 1999].

Requirements management: Communication with the customer and documentation of the agreed upon requirements are always important. Commitments and requirements for the work to be performed should always be documented - this is crucial for clarification and conflict resolution during the lifetime of the project.

Software project planning: A plan makes it possible to move forward in the right direction and to measure progress. The planning at CMM level 2 focuses on project planning, but a project can also be the next baseline update or major revision of a system in a maintenance setting.

Software project tracking and oversight: It is always important to know what you have accomplished in relation to what you have committed to. When measuring progress it is advisable to track work interval relative to project size and complexity.

Software subcontract management: The introductory question to this KPA reveals whether or not this KPA is at all relevant.

Software quality assurance (SQA): Many organizations will not have a responsible person for this work, and the important thing is to see that the requirements for the KPA are satisfied.

Software configuration management: As with SQA, a defined role or control board may not be advisable for the organization, but keeping track of changes is always important.

6.2 Supporting material for tailoring of the CMM

- The CAF [Masters & Bothwell, 1995] gives hints as to how to utilize the CMM in a specific context and be sure to include the essence of the CMM
- CBA IPI gives a description of the process of conducting an internal appraisal in an organization and can be used as a guideline for conducting a CAF compliant appraisal

6.2.1 FAQT: Flexible Assessment Questionnaire Tool - Method description

In the CMM-based assessment in Telenor Mobil IT we used the FAQT in the conduction process. The method for developing the FAQT was inspired by the CBA IPI. However, there are a few areas where the methods differ:

1. The FAQT covers only CMM level 2, but in more detail than the CBA IPI, while the CBA IPI covers all five levels in the CMM
2. The CBA IPI describes an on-site visit for gaining understanding of the software process based on analyzed and identified key process areas described in CMM from the Maturity Questionnaire responses that need further elaboration. The method recommendations regarding the FAQT describe a discussion round at the end of the assessment process to replace the on-site visit.
3. CBA IPI also describes a phase of document review to find supporting material for the data collected in the questionnaire phase and on-site visit (discussion round). This phase is excluded in the FAQT.

The assessment method for using the FAQT is developed according to *some* of the requirements in the CAF [Masters & Bothwell, 1995]. The reason for this is that the developers of the FAQT [Arent & Iversen, 1996] have evaluated some of the requirements as unnecessary or irrelevant and have therefore excluded them in the tool, or they have concluded that some requirements are met in other satisfied CAF-compliant requirements. When deciding to use the FAQT in the assessment process in Telenor Mobil IT, the initiators relied on the competence of the FAQT developers and held in good faith the decisions they made as they were developing the tool. The final method related to FAQT was developed based on experiences from two experiments in two Danish systems development organizations, and based on these experiences Arent and Iversen (1996) make recommendations on how to get the most out of the FAQT method, in line with other professionals' and practitioners' recommendations regarding successful SPI [Arent & Iversen, 1996, Paulk, 1999, Bamberger, 1997, Ginsberg & Quinn, 1995, Paulk, Weber, Curtis & Chrissis, 1994, Mathiassen & Ngwenyama, 2002]. For detailed method description of the FAQT, see Arent and Iversen (1996).

6.3 Using the FAQT

6.3.1 Planning and preparing

As we prepared for the CMM-based assessment in Telenor Mobil IT, we discussed necessary resources to conduct the assessment using the FAQT. We decided that the appraisal team would go through the data reports and thoroughly discuss the data we had and how to use it, and that we would arrange for a presentation of the results and a discussion after the assessment was conducted. We wanted team leaders and management to participate at this presentation. The appraisal team consisted

of two persons who knew the organization well - one of them being an employee in the department, and one person with theoretical knowledge about the CMM.

The translation of the database did not only make the content easier to read for the participants, but the process of translating also increased the knowledge about the FAQT. We felt confident that we could use the FAQT with success even if we lacked the recommended experience in using the tool, as we had connections to professionals that had aided in the development of the tool and experience in using it. The appraisal team did initially lack the knowledge needed about Microsoft Access 97 database to use the FAQT, but this was solved by setting aside two weeks to learn the basic functions of a Microsoft Access database and the FAQT (including translating the content).

The resources we decided was necessary for the assessment were in compliance with the minimum resources required to conduct an assessment using the FAQT as described.

To stimulate motivation for maturity assessments and SPI work in the future and to increase awareness about software process practice in the organization and about the CMM, management had decided that all employees should respond to the questionnaire. This would also give employees an equal opportunity to make improvement suggestions, and as neither management nor the appraisal team had suspicions as to what group or what persons might have ideas and reflected suggestions for the department as a whole, this was a good way of locating potential resource persons for further work.

CAF makes strict requirements to the members of the appraisal team, but these requirements should only be seen as a guide [Arent & Iversen, 1996], and we evaluated our collective competence as adequate for conducting a CMM-based assessment. When using the FAQT in such an assessment, there are some additional requirements related to the team's knowledge about the method described for using FAQT, the appraisal team's objectivity and the appraisal team's ability to induce change - these additional requirements were also evaluated as a guide. Management had informed the employees in the department about the assessment, and given instructions about what was expected of each employee. This information coming from management might have contributed to cooperation from almost all participants, both at the middle management level and practitioners at lower levels in the organizational hierarchy.

The appraisal team had defined the scope in the organization, and the CMM scope and an abstract goal for the assessment. A rough plan was developed for the assessment process, including preparation of the questionnaire, handing out the questionnaire, filling in the questionnaire and registering the responses.

In accordance with the recommendations in Arent and Iversen's (1996), we evaluated the original questionnaire in the FAQT thoroughly and tailored it for use in the department. The deviance from the original questionnaire to the tailored form was:

- ➢ Translation from Danish to Norwegian
- ➢ Additions to the introduction, for example:
    - o Information about how the maintenance department should interpret the questions and that KPA 1, 2 and 3 should be ignored if they seemed irrelevant for the respondent's work.
    - o Contact information to the members in the appraisal team
- ➢ Tailoring of the introduction questions to the department, for example:
    - o Formulation of the questions was tailored to the department's structure and tasks
    - o Additional questions about role and placement in the organization

We wanted to get as much information about the respondents as possible, as we were prepared to find unsuspected patterns in the data collected for the respondents.

The FAQT method description emphasizes the importance of *anonymity* when conducting an assessment using FAQT, and we decided to highlight this in the introduction. Unfortunately, there were about 1.5 % of the respondents who doubted the anonymity issue and refused to respond to the questionnaire. This percentage was so low that it did not affect the results.

The participants in the assessment were only given an introduction to the assessment by e-mail that included:

1. A short presentation of the CMM
2. The method to be used and
3. The abstract goals of the project

This information was sent out by the local contact person in the department. Whatever information about the assessment we felt was lacking in the introductory e-mail was written in the introduction to the questionnaire. At the time the e-mail was sent out, there were decisions about the assessment process and the questionnaire that had not been made yet, and the local contact person had at that time limited knowledge about the FAQT so supplement information was needed when the questionnaires were handed out.

6.3.2 Conducting

It would have been difficult to find a calm and non-disturbing environment for all employees to respond to the questionnaire as recommended, so the participants were instead given a week to respond, with the opportunity of contacting the appraisal team members by telephone.
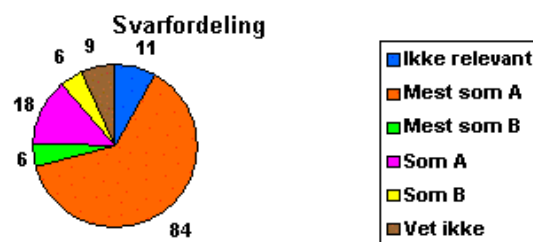
The registration of the questionnaire responses was done by me, but this work took longer time than estimated in the method description because one person was doing the job instead of two as recommended. Depending on the amount of comments made in the responses, registering a response took from 5 to 45 minutes.

Each question in one KPA is formulated into a question with two following statements that the respondent has to rank according to practice in the organization. Each KPA consists of 10-15 of these question/statements, some of them being calculated according to the KPAs' common features: some question/statements are weighted in the KPAs goals, some in measurement and verification, and some in commitment and ability to perform. Below are two examples of question/statements with result graph and description of what common feature the question is weighted against:

[Figure: Question/statement from FAQT with result graph and description of weighing: Goal 3]

1.14 I hvilket omfang behandles prosjektets aktiviteter forbundet med kravshåntering på prosjektets kvalitetsmøter?

A   I vårt prosjekt gjennomgås aktiviteter og produkter forbundet med kravhåndtering på et eller flere av prosjektets kvalitetsmøter.

B   I vårt prosjekt blir ikke aktiviteter og produkter forbundet med kravstyring behandlet på projektets kvalitetsmøter.

[Figure: Question/statement from FAQT with result graph and description of weighing: Measurement and verification]

6.3.3 Generation of data

The FAQT automatically generates data reports from the registered in the database, and organizes the data findings in a series of graphs. These graphs can be very helpful in seeing relationships between the fulfillment at KPAs at CMM level 2 and for example roles and projects, and there is a graph for just about all the information gathered in the questionnaire. These graphs are very helpful in the analysis phase of the assessment process, as they show the relationships between the different findings, but it is the appraisal team that has to evaluate and interpret the results to make reasonable decisions about how to go about the results.

The result report generated in FAQT needed tailoring to Telenor Mobil IT and the chosen representation of the KPA profiles in Telenor Mobil IT consists of four parts:

Respondent profiles

Respondent profiles give a general characteristic of the respondents that have participated in the assessment. The profiles are based on personal data from the introductory questions in the questionnaire.

Maturity profiles:

In the data report three graphs are presented that give an image of CMM level 2 maturity profile for all six KPAs within a specific part of Telenor Mobil IT. These graphs give an image of

- o The maturity profile for Telenor Mobil IT as a whole
- o The maturity profile for each department or group
- o The maturity profile for the different project types in the organization

For example: The following figure shows the maturity profile with fulfillment percent for each KPA for the four groups in the Telenor Mobil IT department:
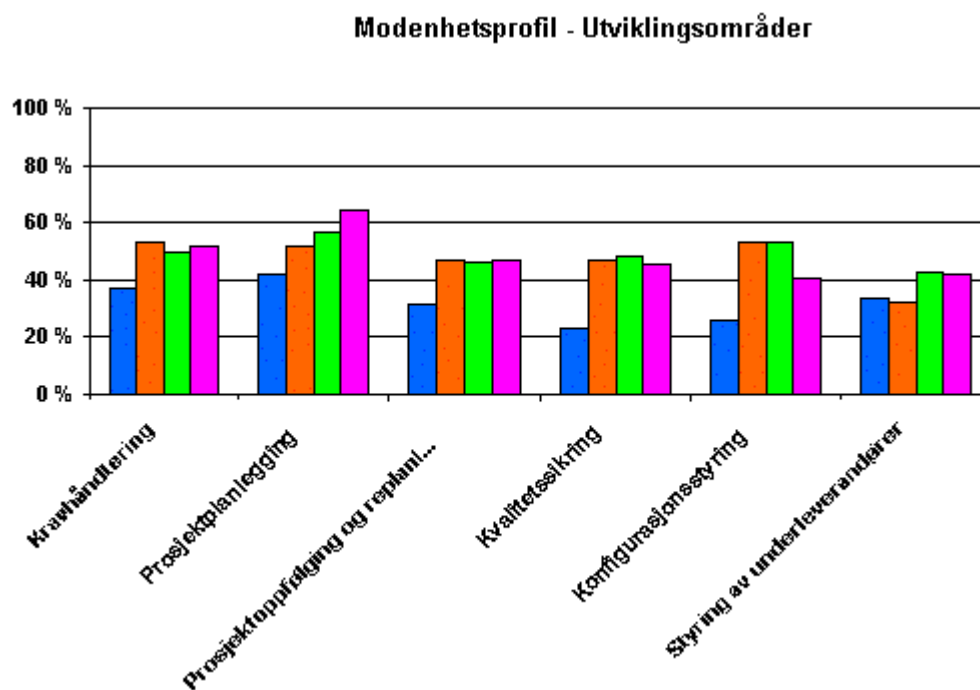
[Figure: Example of Maturity Profile: Fulfillment percent for each KPA/groups]

The fulfillment percent for each KPA was similar for the department as a whole, as is visible from the following figure:

Modenhetsprofil - Telenor Mobil IT
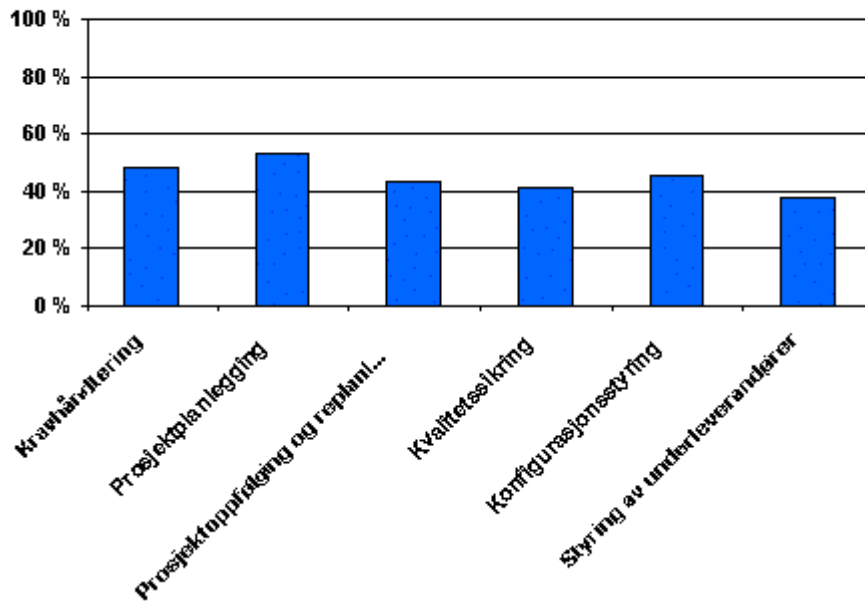
[Figure: Maturity profile – Telenor Mobil IT]

This finding could indicate that the assessment process was conducted without the necessary knowledge about CMM. I would have expected to see more variations over the different KPAs for a department as Telenor Mobil IT, where the different groups within the department have different focus areas related to IT. Some KPAs should be more important for the department than others, but this was not evident in the initial results. While registering the responses I observed that there appeared to be a relationship between a respondent's role in a project or a team and her response. When analyzing the results, we decided to add a diagram showing this relation in the complete result report – we concluded that there were some persons that were expected to know more about certain aspects of the project phases than others because of their role in the project. For example: A project manager would be expected to know more about the department's practices in relation to organizational standards and procedures than a lower level developer.
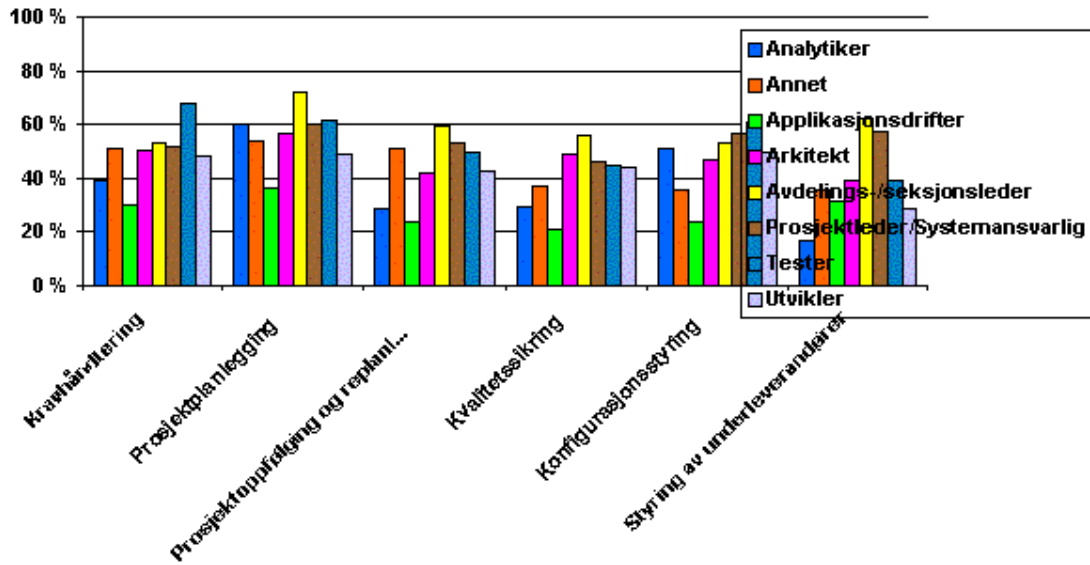
[Figure: Fulfillment percent role/KPA]

The differences in KPA fulfillment between the different groups within the department were quite similar, which may indicate that the understanding of the KPAs, or the objectivity of the respondents, is not as high as it ideally should be. However, one group clearly stood out, and we are quite sure that was due to the irrelevance of KPAs at CMM level 2 for the work they conducted (which was mainly maintenance work). One could expect to see a wider range of fulfillment percentages relative to the groups' tasks within the department, which was mainly maintenance work. For example: a group whose major projects focuses on deliverance of IT systems would be expected to score much higher relative to CMM level 2 than a group concerned with maintenance work. The FAQT calculates results in such a way that "do not know" counts as negative, while "not relevant" does not count in the calculations of maturity [Kristensen, 1998] (see special graph 4 for the relationship between these responses under **Special Graphs** in this section). Another problem with the produced results from the FAQT is that it is hard to find the relationship between the roles within the different groups. This would have been interesting to look at because the roles represented in the existing result reports show all responses for a role regardless of group – where the tasks can differ so much that an "analyst" in one group may not be doing the same work as an analyst in another group.

This relationship is possible to look into by taking all the data and make a database for each group.

Detailed profiles for each KPA:

Detailed profiles for each KPA: In the data report a detailed profile of each KPA at CMM level 2 is presented, and each of these profiles consist of the following:

a. A description of the KPA and related goals
b. Three graphs that give an image of the fulfillment of goals related to the KPA: Telenor Mobil IT, focus areas for development, project types and roles
c. Three graphs that give an image of the fulfillment of questions related to the KPA: Telenor Mobil IT, Focus areas for development, project types and roles
d. A summary of the KPAs questions with comments made by the respondents
e. The respondents' final remarks on each KPA

The following graph shows the fulfillment percent for each question within one KPA:

Oppfyllelsesprosent for innsatsområdets spørsmål - Telenor Mobil IT
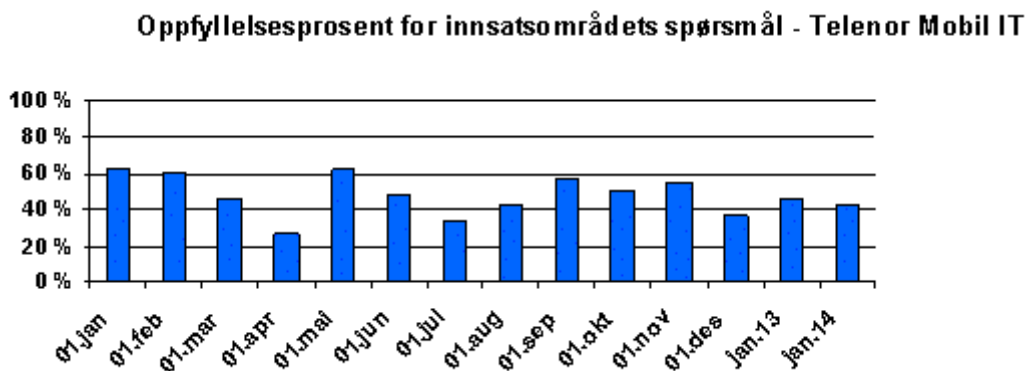
[Figure: Fulfillment percent for each question for a KPA. Note: The dates on the x-axis represent the question numbers within the KPA, but are shown as dates probably due to conversion error in MS Access]

Special graphs

At the end of the data report several special graphs are presented. These graphs are related to the common feature for each KPA and show the relationship between the fulfillments of the common features for each KPA. The **special graphs** give an image of

1. The fulfillment percent for allocated resources for each of the six KPAs (common feature *ability to perform*).
2. The fulfillment percent of quality meetings in relation to the activities within each KPA, with the exception of Quality Assurance (common feature *verifying implementation*).

3. The fulfillment percent for use of documented procedures within each of the six KPAs (part of common feature *commitment to perform)*:

Bruk av dokumenterte prosedyrer innen innsatsområdene
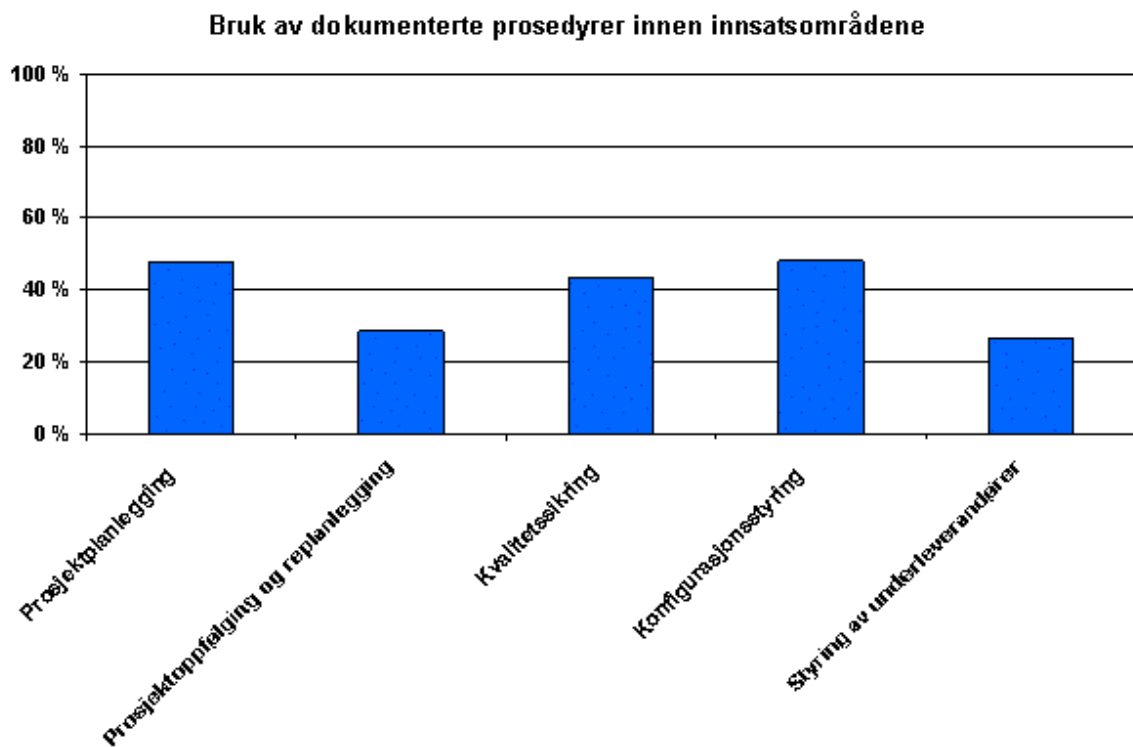
4. The accumulated number of "Do not know" and "Not relevant" for each of the six KPAs:

Antall VET IKKE og IKKE RELEVANT fordelt på innsatsområdene
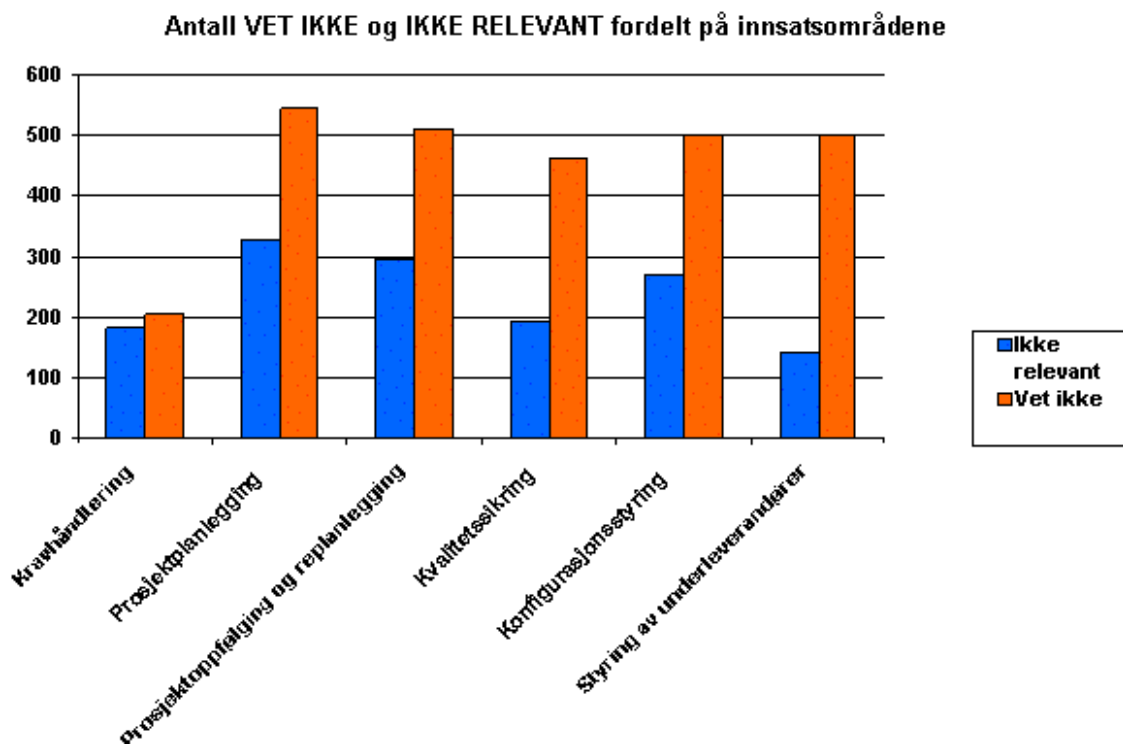
5. The relation between the total number of "Do not know" and the system development experience in the unit for developers and project managers

6. The relation between the total numbers of "Do not know" and the general experience as system developer for developers and project managers (as some roles are connected to a certain KPA and should score higher than other roles.)

6.3.4 Evaluation of results

The data from the FAQT had to be evaluated -

What does this data tell us about software processes in Telenor Mobil IT? In what areas of the software processes are there good practices? Are these good practices relative to certain groups in the department? Where are the most pressing needs of improvement? How much confidence can we put in the results?

The process of evaluating the data from the assessment was done in the following steps (much like the steps in CAF requirement 20):

1. Information was extracted from gathered data as the responses were registered in the data base

2. Each appraisal team member read through the result report on their own making notes

3. The appraisal team got together and classified the findings in terms of CMM and as general strengths and weaknesses in the department, based on the CMM-based questions and the summarizing questions for each KPA.

6.3.5 Reporting

We prepared a presentation for the department management based on observations and the result report. In addition, the local contact person made presentations of the results for each group in the department that were presented and discussed within each group. The presentations consisted of:

- ➢ An overview of CMM
- ➢ Information about the assessment, FAQT and the questionnaire
- ➢ Main findings
- ➢ Discussion round

6.4 Assessing CMM level 2 maturity in Telenor Business Communications, Information Systems and Project Management

6.4.1 Planning and preparing

The assessment in the *Information Systems and Project Management* (ISPM) department did not require as much preparation as the Telenor Mobil IT case. Most of the members of the appraisal team in this assessment had experience from the Telenor Mobil IT case – we were familiar with the key process areas and goals of CMM level 2, and had experience that we might benefit from in the assessment of the ISPM department.

In ISPM we decided to tailor the CMM framework so we would get more in-depth information and understanding about the department's software processes than the FAQT would give us. We decided to use the Maturity Questionnaire, the same questionnaire Lead Assessors use when performing a CBA IPI in an organization, to interview employees. However, we assumed that interpretation and tailoring was necessary and did an in-depth study of the questions. The Maturity Questionnaire consists of questions aiming to address the most important issues in the KPAs, but the questions require a deep understanding of the CMM, both by interviewers and interviewees.

The only acquaintance we knew that the employees had of the CMM was the introduction we had held when presenting the assessment process for the department, and to get the most out of the data from an interview situation, we decided it might be advantageous to know about the interviewee's knowledge regarding the CMM to evaluate the responses more critically. The local contact person also wanted to know what the employees thought of as strengths and weaknesses about the software process practices in the department, and thereby give the employees a chance to contribute to change and improvement.

Based on these motivations, the interview guide based on the Maturity Questionnaire was added to with the following introductory questions:

➢ Do you have any knowledge about or experience with CMM? / Did you attend the awareness meeting regarding this assessment?
➢ Do you have any earlier experiences with assessments like this?
➢ In your opinion, what are the departments' strengths and weaknesses?
➢ What are the most important improvement areas for the department?

When looking at the CMM questions in the questionnaire, the first issue we considered was the CMM terminology. For example: What does "a group" really mean? In CMM a group can be one or several persons working part-time or full-time, and this is important to be aware of because a lot of the key practice questions evolve around different groups with specific responsibilities. We interpreted the group concept as a means for ensuring certain activities are performed.

In advance of the interviews we decided to divide the interviewees in two groups; one testing group where we would conduct interviews with 1-3 persons from the same group, and we would do this in a few different groups in the department. We were hoping this strategy would help us in mapping how well the questionnaire fit the department so that we could tailor the questions for the second round of interviews.

We were aware that the department's *customer situation* was rather different from the one assumed in the CMM, and we were prepared to make changes to the interview guide as we learned more about the department's customers in the first interviewing round. The department's customers were within the same organization, and did not necessarily represent the users of the system.

6.4.2 Conducting

First interview round

Whenever the respondents had trouble answering the questions from the Maturity Questionnaire, or no interesting or seemingly relevant information was added to the information we had from earlier interviews, we asked additional clarifying questions about the situation. We tailored the CMM directly in the interviewing situation in regards to *formality, frequency* and *granularity* when appropriate, and my adviser's former experience made this particular tailoring of the argument justifiable.

A few questions were added to the Maturity Questionnaire in the interview guide to get a deeper understanding of the software processes in the department and not just compliance regarding the CMM practices. CMM puts emphasis on many defined roles, and if these were not defined in the department we analyzed how things were defined differently in the department and possible reasons for this.

On questions regarding measuring status (the *Measurement and Analysis* common feature) in relation to each KPA, the following questions were added:

1. Does anyone perform a check or something similar to a check?
2. Regarding the Requirements Management KPA:
    a. Can you give examples of experienced problems?
    b. Do you have any idea about the cause of the problems?
    c. How often (or to what degree are these problems experiences?

Regarding the Quality Assurance KPA, the following questions were added:

1. Does anyone perform a check or something similar to a check?
2. Closing questions for each KPA:
    a. What experienced problems have you not yet mentioned?
    b. Do you miss anything particular related to this KPA, or do you have any suggestions for improvements?

Other process elements that we concentrated on were criteria for considering the order and completion of activities, for example exit criteria for one specific activity:

    c. When do you consider an activity completed?

Whenever there was enough time a couple of questions from CMM level 3 were asked (because management was interested to see of anything from that level seemed to be relevant for the department). These questions concerned *training* and *peer reviews*.

When we completed the first round of interviews we had found that not all the questions in the form were appropriate for the kind of work the different groups were doing on a day-to-day basis, and also, a lot of the concepts addressed in the questionnaire were unfamiliar in the form presented, so further adjustments in the translation was needed.

Second interview round

We suspected that prioritizing the requirements coming in from different customers might be a challenge, and in the second round of interviews we tried to address this issue of the software process in our questions. Based in the experiences from the first interview round we developed a second interview guide that was tailored to the organizational context in the ISPM department. When

conducting the interviews in the second round the questions were less structured, to find out if goals for the different KPAs were met even though the formality, frequency, granularity and scope might differ from the requirements described in the CMM. The need for details concerning these attributes may vary in organizations depending on organizational structure, customer involvement and the nature of the software that the organization develops or maintains. We found that the work in the department could be categorized into *Development* and *Maintenance*.

The maintenance work is based on an incoming stream of demands rather than a Requirements document. These demands can be of different nature including:

- Bugs
- Misunderstandings
- Large and small improvements suggestions etc

Terms that were changed in the final interview guide were *incoming requests* instead of *requirements* and *tasks* instead of *projects*.

There are also two major considerations we wanted to add to the second round of interviews:

- Internally: Does the prioritization of incoming requests that takes place seem to be correct and how is it done?
- Customer satisfaction: are we satisfying the service?

I tried to capture these considerations in the new interview guide, and below are some examples of new questions to each of the 6 KPAs:

1. *Requirements Management:*
    a. Who makes the requirements (what role)?
    b. In what form are the incoming requirements (oral/requirements document/e-mail)?
    c. How many requirements are typically in the to-do pile?
    d. How many of the requirements are described/explained well enough to get working on right away without further elaboration?
    e. How many of the incoming requests regard faults, ad hoc wishes of improvement, well-argued wishes for improvement, misunderstanding, and other requests?
2. *Project planning:*

a. How much of your time is spend on planned expansion of the product versus "pure" requests?

b. How are the incoming requests prioritized?

c. Is there a written policy for prioritization of the incoming requests? For example: are any customers prioritized over others?

d. When initiating the work with a request: how do you prioritize the requirements, or has the customer already prioritized them?

The KPA *Project Tracking and Oversight* was renamed *Tracking and Reprioritizing*, based on the department's tasks and work processes, and a small number of questions were removed because they concerned project related work.

Questions regarding KPAs *Sub Contract Management* and *Quality Assurance* remained unchanged as we felt the issued addressed here were important for both kinds of work being done in the department.

In the *Configuration Management* chapter, an introductory question regarding the process towards the release of a system was added because the questions in the original interview guide did not capture the criteria for considering the order and completion of activities:

1. How do you decide when to release, and how do you undergo this process? (For example: Is there an Acceptance Test that has to be approved?)

6.5 Discussion

When deciding what method to use for assessing an organization's software processes there are several issues that the organization and the appraisal team should consider in advance of the assessment conduction. The choice of approach should reflect the situation in the organization to give the most valid results to work with in the SPI effort. When discussing the threats to validity of the results in the two cases in Telenor I will consider the pros and cons of each method used in the two cases in general and of these approaches to CMM more specifically.

Telenor Mobil IT

The assessment method used in Telenor Mobil IT has characteristics that highly threaten the validity of the results. These threats to validity should carefully be considered when making decisions about how to present the results, to whom, and how the results should be used. I have no basis for making an

analysis of the effects these threats to validity have actually had on the case in Telenor Mobil IT as there are no post-assessment data available. However, the threats to validity of the results from the assessment are:

- ➢ Internal versus external evaluation: objectivity might be easier for external people:
  - o Evaluation related to the Telenor Mobil IT case involves two things:
    - ▪ The respondents' evaluation of the questions: Respondents' might have political interests that may influence their response, and when filling out a questionnaire the team that evaluated the data from the survey will not be able to see such a motivation.
    - ▪ The evaluation team consisted of internal personnel that may have had stake in the outcome of the results of the assessment.
- ➢ Comments and results indicated different interpretations of concepts. This threat to validity could have been reduced by conducting a more thorough awareness phase in advance of the assessment.
- ➢ Very short assessment time frame resulting in:
  - o Inadequate tailoring to local contexts
  - o Lack of document review: Questionnaire responses is the sole data source, and the respondents may have stake in responding the way they do, so the appraisal team should have conducted document reviews to make sure people actually do what they say they do.
  - o Limited information to respondents about the assessment – resulting in lack of awareness

Telenor Business Communication, ISPM

In the case in the ISPM department, there are also threats to the validity of the data gathered that should be considered when analyzing the results from the assessment:

- ➢ The questions that we asked in the interviews were only a selection of questions regarding CMM level 2 compliance, and some aspects of the department's software process in relation to CMM level 2 may not have become obvious in the interview data.
- ➢ Lack of document review: no data was gathered to verify supplement results from the interview process.

> ➤ The only post-interview that I conducted was with a stakeholder: one of the people that initiated the assessment. His evaluation of the assessment outcome may have been overly positive in relation to actual outcome. However, from the answers I received I do not think that was the case. In general, it is advisable to talk to more than one person regarding the outcome of a CMM assessment to get a wider perspective of the actual outcome, and to keep in mind any political sympathies that may influence the response. It has not been easy to get access to people and information regarding the ISPM assessment's outcome due to the reorganization of the unit and I can not see that the person I talked to had any motive for bias.

Based on the experiences from the cases in Telenor, these are some of the most important issues to think about for an organization when selecting assessment approach, and these are discussed in the following sections.

6.5.1 What is the scope of the assessment?

The primary goal of the CMM assessment in the organization is the first clue as to what approach seems most beneficial. One should be careful in selecting a framework to guide the SPI effort without reflection on the framework's primary focus relative to the organization's primary focus with the assessment.

When planning and preparing for the appraisals in Telenor, goals of the appraisal and constraints were discussed in the appraisal teams, in terms of organizational scope and CMM scope. All groups of both departments were decided to participate, and in both cases, the period for collecting data was short, especially in Telenor Mobil IT. I was surprised to see the high respondent rate in Telenor Mobil IT, especially in the timeframe people had to respond – this was a positive experience and is a well-founded argument for using a survey as a quick way of assessing an organizational unit in Telenor. However, for an assessment process using the FAQT to be successful, it is necessary to make sure the participants understand what the assessment regards. The tool uses words and concepts from the CMM that requires an understanding of the framework's presentation of practices, intentions and goals, and I do not believe this understanding can be achieved solely through e-mails and a thorough textual introduction.

Regardless of appraisal method being used, the awareness phase of an appraisal is crucial for the success of the assessment's focus – if CMM is to guide the effort, the organization has to make sure that the KPAs and goals comply with the organization's practice areas and goals of the software processes.

6.5.2 Awareness – in the organization and in the appraisal team

Awareness regarding the focus of the assessment in the organization is crucial for the data to be valid and useful in further planning of the SPI effort. The appraisal team has to know the CMM very well and understand the goals of the practices in the CMM to be able to make a valid interpretation of the organization's fulfillment of CMM goals. These goals provide a structure for making this interpretation.

The participants need knowledge about the assessment and the CMM to be able to answer the questions relative to their work practices. The language and concepts in the CMM is by no means self-explaining, and many organizations use other words and phrases for the same concepts as those described in the CMM, but this has to be explained. The same issues are relevant for tailoring the CMM to an organizational context as for making the involved people aware of the goal, focus and intent of the CMM assessment. The participants in the assessment should also be introduced to the KPAs in focus to make sure they understand what they focus on and what the KPA goals are related to. An awareness phase covering these issues will help the respondents comprehend the questions in the assessment phase in line with the assessment goals, and the questions are perceived more appropriate for the organization's practices.

Appraisal teams

The appraisal teams included some of the same members in both cases, the main difference being that in each case a representative from the assessed department participated, and in ISPM we had an experienced assessor in the team as well. In Telenor Mobil IT, we used an already developed method and tool for the assessment and it was not necessary to have as much experience in using the CMM as in ISPM, where we freely defined the assessment method, with help from an experienced assessor. On the other hand, in the evaluation phase we realized that our CMM experience was a little short and took advantage of the contact persons from the Aalborg milieu.

Participants and information

The selection of participants in Telenor Mobil IT was done before the appraisal team got together. All employees in the department were to participate in the assessment. The obvious opportunities in this decision are that the awareness about CMM and internal software processes is likely to increase, and everyone has the opportunity to contribute to change. Making a more reflected decision when selecting participants might have resulted in less negative feedback and attitude towards CMM. As I was registering the responses, I read many negative comments regarding the questionnaire (and only two

positive!). Most of these comments were about the relevance of the KPAs to the employees' work. The awareness about CMM has certainly increased in the department, because all employees participated in the survey, but has it been beneficial? Perhaps the selection of participants should be based on CMM level 2 key practices related to the different groups' work and we should have made separate questionnaires for these groups?

We did not necessarily need all the information from the responses to create a useful and correct image of the situation related to CMM level 2 in the unit, and the assessment was more costly than necessary by including all employees rather than making a representative selection. However, the department's management did the selection of participants and the appraisal team could not overrun this decision. Planning an awareness meeting for the participants before the conduction of the assessment posed an important question:

How should we to find a time and place for all employees to attend?

With the introductory e-mail in mind, we tried to overcome this obstacle by working on the introduction and guidance in the questionnaire, but it seemed like a portion of the respondents did not read these chapters in the questionnaire before responding, and I believe this resulted in many of the negative comments towards the questionnaire:

- ➢ The respondents did not read the information about what parts where perceived relevant related to their belonging group, and
- ➢ A lot of the respondents had difficulty interpreting the KPAs when filling in the questionnaire

An awareness meeting in advance of the assessment would have reduced some of the negativism about the questionnaire, and resulted in more people completing the form thoroughly. These experiences show how important it is to make sure the participants are aware of what a CMM-based assessment is all about – and the e-mail that was sent out in addition to the textual descriptions in the questionnaire was not enough to prevent misunderstandings regarding the assessment and subjective interpretations of the concepts described.

The contact person from the ISPM department aided the appraisal team in selecting participants from that department. We based the selection on groups and systems or projects in the department, where the local contact person was very helpful, and we even planned to make a new selection after interview round one, based on a need for a broader scope or deeper insight in the department. The contact person knew the groups and people in the department quite well and picked people he thought could aid in achieving the goals of the assessment. In the ISPM department, we had an awareness

meeting in advance of the assessment, where the appraisal team introduced the goals and intents of the assessment in the department and the CMM. Whatever knowledge about the CMM and the assessment the participants did not comprehend from the awareness meeting could be solved in the interview situations.

6.5.3 Choose approach based on assessment goals

Data collection
There are several methods for collecting data when performing an appraisal [Masters & Bothwell, 1995], all with different opportunities and constraints. These opportunities and constraints should be weighed up against each other and linked to the goals of the appraisal before selecting data collection method.

Using the FAQT in the assessment process is a relatively quick and easy way to conduct an assessment, and it might be easier to convince management of performing an assessment when the tools are already available for doing this kind of work. However, this strategy for conducting a CMM-based assessment includes risks:

➢ A lot of qualitative data is lost when people are crossing off answers and not formulating own sentences:
  o Relevant information beyond the scope of the questions in the questionnaire will not be reported, or there is at least less chance of this as an interviewer in this situation is more likely to make a good judgment as to what is relevant than the respondent and ask supplement questions
  o Valuable observations may not be documented
  o Follow-up questions may not relate to the respondent's response to the original questions
➢ A questionnaire-based assessment does not provide much opportunity to eliminate misinterpretations that may occur [Masters & Bothwell, 1995]:
  o Respondents may misinterpret questions (no chance of asking questions like in an interview situation)
  o The appraisal team may misinterpret answers
➢ Statistical data is not proper for evaluating qualitative characteristics about software processes:
  o The results should only be used to show the relationship between fulfillment of KPAs

      o   Improvement efforts should be based on identification of which practices seem to be working and which practices seem not to be working in the department and the FAQT results do not give data in this respect.

As oppose to using a quantitative method for collecting data, interviews as a means of recording data provide opportunity to build rapport between the interviewer and the interviewee [Masters & Bothwell, 1995].

      Our experience from the interviewing situation in ISPM is that the interviewer can adjust the topics covered during the interview to probe for particular strengths and weaknesses, and perhaps make judgments regarding KPA relevance more easily than the assessment participants do. However, there are drawbacks to this method as well:

➢   Recording the data in an interview situation is challenging, but to overcome this challenge we were two members of the assessment team present in the first interviews, and with a little experience from such an interview situation, it was easier to seek out the relevant information.

Data analysis

The FAQT rates the fulfillment of the KPAs related to CMM level 2, but the assessment team had to decide what data to present for different interest groups from this information. The FAQT generates data based on the *fulfillment of KPAs at CMM level 2*, based on key practices at that level. The data is traceable to the FAQT database in Telenor Mobil IT.

      In the ISPM case, we went through the process of validating the data before the second interview round, as we were out *to get an understanding of the situation* in relation to CMM key practices at CMM level 2. Because of the sudden reorganization of the unit the data from this assessment is unfortunately not traceable (only a draft summary of the interviews by me), and the assessment team never got as far as making a rough rating of the department, but there are clear indications from the interviews about the department's maturity.

Internal versus external appraisal team members

When choosing method for assessing the software processes in the organization related to CMM, an organization should also evaluate advantages and disadvantages of using a method where most of the team is external or most of the team is internal. An external team will not have any preconceived notions about the organization, and the assessment results' credibility might be higher. The team will be independent of the organization and have no stake in the assessment results. The external team should consist of professionals in the CMM and can provide the organization with several best practice perspectives. An internal team on the other hand has the advantage of knowing the organization very well and may not need as much time getting an understanding of the situation, and

the knowledge gained from an assessment is an invaluable experience. In addition, in general, an internal team is less costly and requires less coordination.

A combination of internal and external team members on the appraisal team seems like a good solution. The team will have knowledge about the organization that will decrease the time for assessment since some members are familiar with the organization and the process, while the external team members will add an objective view to the evaluation of the software process in relation to CMM practices, and can provide the organization with advice for improvements based on their various areas of expertise.

In summary, the choice of method should always reflect the business and appraisal goals, and the results of an appraisal have to be translated into meaningful information relative to the sponsor's business needs.

6.5.4 What is expected to become of the assessment results?

Probably the best indication of what method approach to take is what the plans are for the results. If the results of the assessment are to be used in further planning of a SPI program, the appraisal team and the organization should be confident that the results are valid and detailed enough to base all future SPI work on them.

The appraisal teams planned the reporting processes equally in the two cases and this process corresponds to recommendations made. Unfortunately, the ISPM department did not exist long enough to get to this phase.

The final presentation and discussion round with the management groups in the Telenor Mobil IT was successful in varying degrees. Some of the groups were very positive to the assessment and saw this as a way to seek out areas to improve. In addition, some experienced problems were now documented and more detailed information was available that made them easier to address. Members of other groups were reluctant to hear both the assessment and the value of the results, most of all because they thought the questionnaire was not relevant to their groups' task in the unit. This was also evident from the results, despite our tailoring efforts, and we decided to make a separate database of the IT department within the unit because their work was more in line with maintenance work than project work and their results were clearly different from the other departments'.

FAQT is structured in such a way that the traceability back to one respondent's responses is lost when using the web-based version, and when respondents refer to earlier questions it is not

possible to track the information. This is a clear drawback of the web-based version. In addition, the overall observations that the registering person gets from register complete responses one at a time is lost.

The textual comments from the respondents proved to be very useful when analyzing the results and were very valuable when selecting reports for presentation and discussion.

6.5.5 Document review

As mentioned in the description of the FAQT method, the CBA IPI method description includes description of a document review phase. In none of the cases in Telenor we conducted this phase, and as already mentioned in the analysis of the approaches, this is a serious threat to the validity of the results. The document review phase is meant to supplement the observations made from the initial questionnaire responses. The questionnaire responses should (if following CBA IPI "strict") provide probing points for later activities such as document reviews and interviews. The responses assist the appraisal team in focusing their investigations [Dunaway & Masters, 2001]. The results from a document review phase of an assessment will show any bias from the respondents regarding the results of the assessment. Many organizations have defined guidelines and procedures regarding work processes that employees have the intention of following, and any evidence that they are in fact not following them may be found in documents. The initial questionnaire phase in a CBA IPI is often skipped in an internal and small-scale CBA IPI because the organization and the appraisal team often have an idea where to focus the investigation, but the document review phase should not be skipped because the data from this assessment phase is important to validate data from an interview phase.

6.5.6 Summarizing remarks

I have discussed some of the advantages and disadvantages using one method over the other, but it is hard to continue this line of argument because measurements that show the outcomes of the assessments lacks. However, based on the experiences from Telenor, recommendations from professionals and general method advice from researchers, I will present criteria for success of using the two methods discussed above:

Use a survey-based method only when:	Use an interview method only when:

Primary goal is CMM compliance	Primary goals is locating good/bad practice
A goal of the assessment is to get a broad overview of a pre-defined scope (given by the areas in questions in the survey)	A goal if the assessment is to get in-depth information about a situation based on a reflected selection of participant
All participants are familiar with and have an understanding of the KPAs in the CMM	An appraisal team member has the skills of interviewing and extensive knowledge about the CMM
The appraisal team knows what to look for	The approach is exploratory
The goal is measure progress against former assessments, or evaluating CMM appropriateness	The goal is to locate potential improvement areas – what is the quality of the software processes?

When performing a CMM-based assessment in an organization, the approach should ideally be a mixed approach of quantitative and qualitative methods for gathering software process data [Dunaway & Masters, 2001]. The primary goal of the assessment should guide the organizational approach to software process assessments, and when using a framework like the CMM the assessors' and assessment participants' knowledge about the framework should be considered when choosing approach.

7 Successful SPI in a Telenor-like organization

7.1 Commitment

The CMM-based assessments in the two departments in Telenor that I have discussed in this thesis were initiated by the "grassroots" rather than by management. The motivation for the initiators of the SPI efforts was to increase awareness among employees at lower levels, get data to support their theories about the departments' software practice and to identify best practice. Management in both departments supported the efforts, but did not show much commitment to the results. Telenor is a very large organization with a complex organizational structure. The level of management that supported the SPI efforts in the two departments seemed to be the right organizational level to ask for support, but top management made decisions that influenced the outcome of the CMM-based assessments in the two departments. The goals of the SPI efforts were not aligned with business goals in the sense that they did not require long term commitment and was not aligned with any direct improvement goals. The plans for the results of the assessments were vague – and can be mirrored in low expectations regarding the outcome of the assessments.

Telenor Mobil IT

In Telenor Mobil IT, the assessment results were not intended to stimulate for further SPI work, but to aid as supporting material for future actions regarding software practice procedures. The outcome of the assessment was implementation of certain procedures and tools related to the KPAs at CMM level 2, and the assessment results were used as data for backing these decisions. The plan was to conduct a second assessment using the FAQT, but before that happened the department was split and people transferred to other groups in the organization.

Telenor Business Communications, ISPM

In the ISPM department, the reorganization of Telenor had an immediate effect on the assessment, and the results were not even analyzed before the department was split. This clearly shows lack of management commitment – why start assessing a department to locate improvement areas when reorganization is planned?

The reorganization that happened in Telenor shows lack of management commitment at top level. However, in an organization like Telenor, that is forced to be flexible and able to adapt to a fast changing market, it is hard for management to plan actions at the organizational level at the same as running a business effectively. If the methodology department in Telenor Mobil IT had knowledge about the reorganization, and that the SPI efforts would perhaps not be a long term investment, management in the department may have experienced difficulty running the department effectively due to turf guarding and organizational politics. Assessing the situation in the department in such circumstances would gain nothing – as most respondents would be biased by the fact that the department may be to shut down and the results would not be used to create improvements, and that the "best" running groups are the ones likely to sustain after reorganization.

Both assessment processes in Telenor are characterized by initiative anchored in the methodology departments. Even with supporting statements from management, the SPI efforts were not committed to at a high enough level of management, and as a result the long term investment in SPI failed. The efforts out into the program were allocated resources and economics rather than active involvement in the change process from a management perspective. This should have been an indicator that the efforts might fail: to ensure sustainable improvement commitment and involvement on all levels are required.

Abrahamson (2001) claims that there are critical misconceptions regarding current thinking on commitment in relation to SPI: For sustainable commitment to the SPI effort, stimulus must be triggered regularly, because a person will not truly commit to something that has no value for her, and the level of commitment will not remain the same indefinitely. Commitment will not develop by force, that will at the best only result in compliance [Senge, 1990], which only last as long as a surveillance or control system is in place. Control implies manipulation and may shed negative light on the commitment development [Abrahamsson, 2001]. The response from Telenor Mobil IT indicates that this may be the effect of including all employees in the assessment, and has probably resulted in resistance to change in relation to similar assessments in the organization in the future among some groups. Commitment to SPI activities calls for enrollment, as it implies free choice [Senge, 1990] which is a corner stone in the process of becoming committed [Argyris, 1970]. The employees in Telenor should be made aware of the goals of the measurements and the motivation behind the effort:

What were the rewards and the gains of the assessments?

Change agents and quality managers should focus on commitment from key personnel, as achieving acceptance from majority is often enough for an SPI initiative to succeed [Abrahamsson, 2001]. Telenor should put effort into filling the roles of the IT diffusion process that SPI is. Pries-Heje (2003)

presents a role model for the organizational IT diffusion process with four key roles that has to be filled to ensure successful diffusion. These roles are: owner/sponsor (the person endorsing the project, providing resources, and demanding results), diffusion project manager (the person heading the group that implements the change), champion (the person that in practice affects the target used and ensures the accomplishment of the change), and the user target group (the users, specialists or managers that are to adapt something new). These roles should be filled in the organization when initiating a SPI project. There are certain risks of not having these roles filled: There are other projects going on in the organization at the same time, and the owner has the task of resolving any conflicts among projects. The diffusion project manager's task is to negotiate with potential project management candidates aiming at agreeing on some satisfying conditions regarding the SPI project to ensure success of the effort. The champion works as a change agent in her capability to convince and change people's behavior – filling this role will increase a successful diffusion process dramatically. The target user group needs to be involved because they are the ones who are implementing the improvement efforts in their working practices.
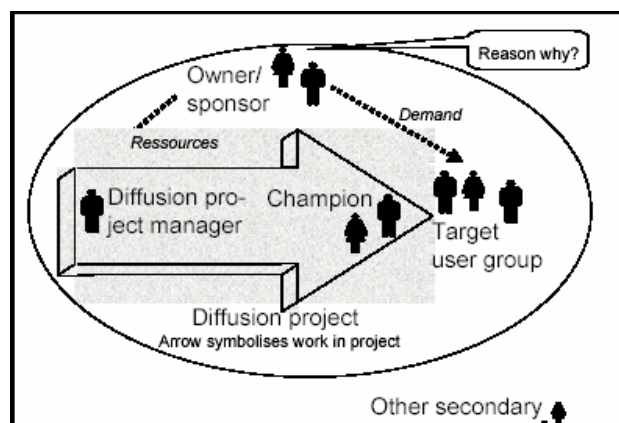
[Figure: Model of primary stakeholders in IT diffusion and adoption [Pries-Heje, 2003]]

Although these groups were focused on in the cases in Telenor, the commitment to the different roles, and the correlation between the roles in the Role Model for Organizational Diffusion Process and the organization roles were not valued enough. The roles in the model above have to be filled, but it is evident from the cases in Telenor that is important to reflect on who is placed in what roles in the model – for example: the owner should be placed at a decision-making management level.

7.2 Management of SPI

The SPI efforts in Telenor were managed by groups that worked as mini SEPG groups. However, the SEPG group's work was not aligned with other initiatives in the departments in such a way that the initiative happened in synergy with other changes in the organization – for example the reorganization of the entire organization. The CMM-based assessment in Telenor was not intended to be the beginning of a long-term investment in SPI, but rather as an awareness initiative to make management and employees focus on software practices. For this, the most important factor in ensuring that the initiative was brought further was including the initiators of the assessments in the methodology department also after reorganization. The initiators clearly realize that changing people's practices requires long-term investment and takes time, and by initiating CMM-based assessments from the grassroots the organization at large "warms up" for SPI efforts in the future as a continuation of the work already done. To ensure future SPI efforts are continued based on the work from the methodology department, the group may have to work harder to obtain support from influential people in the organization to get commitment for the efforts. A plan for what is to become of the results of an assessment and the next step in the effort makes success more readily achieved. A strategy for change with clear goals and objectives, and clear implementation plan with details of plans of actions and responsibilities should be developed and approved by management. The plan can ensure that employees feel a common undertaking and can help build a common understanding among relevant parties about what you are doing and why. If Telenor uses the FAQT in some form in the future assessments, progress would be easy to analyze based on graphs and result reports from earlier assessments.

7.3 Participation

The participation issue in SPI work in Telenor was well-planned and performed. Employees at all levels in the department took part of the assessment, and were given opportunities to make suggestions. The participators were also the people likely to be most affected by any implemented changes as an effect of the assessments and are more likely to accept the change when they can have an effect upon it. Motivation for future SPI work may increase because of employee participation, but Telenor should be careful of not overestimating the value of participation and destroy any initial good will to change. Not all employees have a wish to participate and based on the reorganization after the assessments in Telenor Mobil IT and ISPM, employees may now be skeptic to any SPI initiatives in the organization starting from the grassroots and not by management. Management's credibility regarding commitment

to change initiatives from the grassroots may have weakened and the resistance to change even from the grassroots may have increased. Stressing the issue of management commitment, I will again emphasize the lack of participation from this level in the organization. Stated support to an SPI initiative is not the same as actively taking part in the work being done and *showing* commitment.

Middle management is probably the most important group for the SEPG to ally with. This group acts as change agents when any improvement efforts are implemented and should be taken very seriously when making suggestions regarding the SPI work. In Telenor Mobil IT, these groups (as there were several of them within the department) were the object of the result presentations and informally responsible for taking any action within their group to improve software practices. However, middle management's actions (or any group of participant's), were not tracked after the assessment, and their participating role in the assessment work should perhaps have been more influential for the outcome of the assessment.

Feedback on the progress of the SPI effort is planned in the new organization (including groups from the Telenor Mobil IT department and the ISPM department), which can motivate for future commitment to any SPI efforts. It is important to have in mind, however, that participation and measurement has no value if goals and objectives are not clear and commitment and not present at all levels of the organization.

7.4 Risk management

The choice of using the FAQT to guide the software practice assessment process in Telenor Mobil IT was based on a need to present a predictable assessment method for management to get approval for the initiative.

The FAQT is probably not the best approach to software practice assessment in Telenor. The tool contains information based on perceptions about good software practice several years back, and the software industry has continuously changed after that – in addition to the fact that Telenor is not a typical software organization. First, the CMM version the FAQT is based on is by long been replaced by later versions based in experiences with using the CMM version in FAQT and Telenor should not disregard these experiences but rather look at the improvements in a later version, even another CMM model. Second, CMM may not be the best guide for defining good practice in Telenor. There are other approaches to SPI that may be better suited. In SPI, focus should at all times be on what is relevant for the organization and how the norm should be used most effectively in that setting. Using the FAQT limits Telenor in making these judgments, and the CMM is guiding "good" software practice in the organization without any critical view on relevance for the practices in the organization.

The approach in ISPM showed how CMM may not be the best approach to SPI in Telenor, and experiences from that assessment should aid in designing an assessment approach for the new organization. When selecting assessment approach in the future, the organization should evaluate the new environment the organization is a part of – the context for SPI should influence the approach for improvement. As a starting point I would humbly recommend the organization to look into efforts like ITIL, as this approach may intuitionally seem more relevant for the way Telenor is working with software, and can be confirmed for *at least part of* the organization based on the case in ISPM. In addition I will recommend looking into the Problem Diagnosis Method by Iversen, Nielsen and Nørbjerg (2003). This is an assessment method that alleviates some of the problems with maturity-based approaches. Problem diagnosis targets the organization's key actors – the people with the greatest influence in the development process. Without their commitment and involvement, software processes are unlikely to change. Problem diagnosis elicits and systematizes the problems that key actors perceive in the organization's software process, and is therefore a better starting point for SPI in the departments in Telenor involved with the cases discussed here than an approach starting with focus on CMM.

8 Conclusions and Future work

Focus in this thesis has been on practical use of the CMM model and evaluation of two different approaches to use of the framework. The method evaluations were based on two cases conducted in the leading Norwegian telecommunications company Telenor. In relation to the cases I have discussed how the organization has to prepare for and commit to Software Process Improvement for the efforts to be successful when using the CMM framework as a guide in the assessment process.

8.1 What are the experiences from the assessment processes?

Our experiences with using the FAQT in Telenor Mobil IT were that understanding and using the tool was easy, the response rate was good and the result reports showed results that provided confirmation of known data on the systems engineering process and could be used as arguments to implementing desired efforts from a methodology perspective. Including all employees was an approach to reach the goal of obtaining commitment for change in the department. However, the employees' attitude towards the awareness was not only positive, due to CMM and belonging KPAs irrelevance at CMM level 2 for some of the groups in the department. The awareness in the department regarding CMM and the assessment was low, and the similar results for each KPA indicate low awareness, as one would expect clear differences between the KPAs due to focus area in the department.

Our experiences from the ISPM department are that a less defined assessment process gives us the benefit of re-evaluating focus, participants and guiding tools and frameworks *while conducting* the assessment. The assessment approach was defined based on the reflection that to meet the assessment goals', the approach had to be flexible so it can be adjusted along the way. Despite the qualitative approach we chose, the assessment in ISPM was less costly than the assessment in Telenor Mobil IT because of a reflected selection of participants. The awareness phase in the assessment process in ISPM was done in line with professional's recommendations and the conduction situation had a design that made it easier for participants to get a clearer picture of the assessment goals and the CMM.

8.2 Which method seems to be the best one in a setting such as in the organization at hand?

The CMM-based assessment approach we used in the ISPM department in Telenor is better suited to measure maturity and identify improvement areas and efforts than the approached in Telenor Mobil IT, while the approach in Telenor Mobil IT is a quick and easy way to measure progress and CMM compliance.

Based on the experiences in the two departments in Telenor, I have made the following recommendations regarding CMM-based assessment approach:

Use a survey-based method only when:	Use an interview method only when:
Primary goal is CMM compliance	Primary goals is locating good/bad practice
A goal of the assessment is get a broad overview of a pre-defined scope (given by the areas in questions in the survey)	A goal if the assessment is to get in-depth information about a situation based on a reflected selection of participant
All participants are familiar with and have an understanding of the KPAs in the CMM	An appraisal team member has the skills of interviewing and extensive knowledge about the CMM
The appraisal team knows what to look for	The approach is exploratory
The goal is measure progress against former assessments, or evaluating CMM appropriateness	The goal is to locate potential improvement areas – what is the quality of the software processes?

8.3 What prerequisites were present in the organization when the assessments were initiated? How did the SPI efforts fit into the organizational context? How was the SPI effort managed?

There are premises that need to be present in the organization to ensure success with a SPI effort. These premises relates to how the SPI efforts fit into the organizational context and how the SPI effort was managed. The assessments in Telenor Mobil IT and ISPM were initiated as grassroots efforts and not by management. The grassroots efforts have aided in increasing awareness in the organization

regarding software practice, but claiming that true software process improvement have occurred would be stretching the outcome of the assessments. As the organization as a whole reorganized the departments were split and assessment results are no longer valid for the organization today – although they have given some indications as to what are the main challenges in the new organization.

Management of the SPI efforts were managed by appraisal teams responsible for the whole assessment process and the necessary resources were put aside for successful conductions. The necessary knowledge about the approaches and CMM were present in the appraisal teams, but since this were grassroots efforts, it was important to select an approach that immediately seemed attractive to management, and using an already existing tool to guide the effort in Telenor Mobil IT was a good sales argument for management. As a continuation of this assessment, the organization decided to learn more about different approaches to SPI and CMM and another approach was therefore selected in ISPM. One very important aspect of the management of the assessments was lack of plans for continuation of the SPI efforts. The goals of the assessments were small-scale for using CMM-based approaches, but to get the most out of the results of the assessment and to experience true, measurable improvements in the organization, plans based on experiences and results form the efforts should be developed.

8.4 Lessons learned: what are the prerequisites for successful CMM-based SPI in this type of organization?

Without the listed success criteria present in the organization when initiating SPI efforts, the organization will not be able to implement improvement efforts that will give measurable results and improvements, and it will be hard to sustain the commitment to the SPI effort over time. Based in the experiences from Telenor Mobil IT and ISPM in Telenor, the aspects to put more focus on in future SPI efforts are:

Success Criteria	Includes issues related to
Commitment	Available resources, SPI goals aligned with business goals, realistic expectations, management support
Management	Change perspectives, organization, training, plan, feedback
Participation	Empowerment, organizational learning, institutionalization

Risk management	Norm-based SPI

8.5 *Future work:*

Suggestions for future work regarding the issues considered in this thesis:

> Test out the assessment methods in a Telenor-like organization to get empirical results on the conclusion made in this thesis regarding method recommendation

> The content in FAQT is based on an old version of CBA IPI, which is related to CMM, but any organization using this tool should reflect on the fact that the SW-CMM is slowly being replaced by CMMI and CBA IPI with SCAMPI. The experiences and the learning industry has achieved from this should not be neglected. In addition, the FAQT is developed in an old version of MS Access, and converting to a newer version results in some faults. An organization considering using the FAQT may want to develop a similar database in a later version of MS Access (2000 or later), and should also thoroughly go through the questionnaire to reflect on the assertions in comparing with any CMM model and version that may be more applicable.

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10 APPENDIX A – Post-interview Telenor Mobil IT

Intervjuguide for Mobil IT – 20.09.2004

1. Hvem var det som tok initiativet til CMM-arbeidet i avdelingen? Hvordan kom du i kontakt med Pål Sørgaard?
2. Hvem ga klarsignal til arbeidet, på hvilket grunnlag?
3. Konkrete mål med undersøkelsen?
4. Ble det laget noen resultatrapport utover den generert i FAQT (dette var planlagt) og presentert for ledelsen i Mobil?
   - Ble denne brukt til videre planlegging?
5. Resultatene ble presentert for de ulike ledergruppene? Hvordan var feedback?
6. Ble det planlagt noe videre forbedringsarbeid?
   - Noen konkrete tiltak?
   - Pilotprosjekter?
   - På tvers av gruppene eller kjørte hver gruppe sitt eget løp?
7. Oppfølging av forbedringstiltak?
   - Post-assessment?
   - Videreføring av tiltak til andre deler av avdelingen?
   - Nye tiltak?
8. Hvordan ser avdelingen (gruppe-organiseringen) ut som en følge av reorganiseringen?
9. Har resultatene fra IT blitt brukt etter reorganiseringen?
   - Hvordan? Har de blitt tilpasset den nye organisasjonen? (hvilke grupper eksisterer fremdeles/resultat pr gruppe(fra FAQT))?
10. Hva er planen videre med forbedringsarbeidet?
11. Var det andre effekter av dette arbeidet – positive eller negative – som vi ikke har berørt?

11 APPENDIX B – Post-interview TBC, ISPM

Intervjuguide for ISPL – 17.09.2004

12. Hvem var det som tok initiativet til CMM-arbeidet i avdelingen? Hvordan kom du i kontakt med Pål Sørgaard?

13. Hvem ga klarsignal til arbeidet, på hvilket grunnlag?

14. Målet med undersøkelsen? Identifisere god praksis for å overføre denne til andre grupper i avdelingen? – hvorfor en modenhetsundersøkelse?

15. Hvordan ble det bestemt at det var nettopp CMM som skulle brukes i en modenhetsundersøkelse og ikke andre tilgjengelig modeller?

  ▪ Hvorfor ble ikke FAQT brukt?

16. Etter presentasjonen av CMM og arbeidet som skulle gjøres (allmøte), fikk dere noe feedback fra ansatte?

17. Etter feedback-møte, hva skjedde så? Ble det laget noen rapport/ble arbeidet dokumentert (bortsett fra i min oppgave)?

18. Ble resultatene tatt vare på? Formidlet videre?

19. Hvordan ble avgjørelsen om reorganisering av avdelingen tatt i forhold til avgjørelsen om å foreta en modenhetsundersøkelse? (gjerne tegn og forklar organisasjonsperspektivet her)

20. Hvordan ser den nye organisasjonen ut i forhold til den gamle? (hvor har det blitt av ISPL?) (gjerne tegn og forklar)

21. Har resultatene fra CMM-undersøkelsen hatt noen nytteverdi? Er det noen som har benyttet dem videre?

22. Hva er planen framover i forhold til CMM-arbeid/forbedringsarbeid?

23. Var det andre effekter av dette arbeidet – positive eller negative – som vi ikke har berørt?