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Understanding and Evaluation of Software Process Deviations

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Abstract

Software process improvement is often mentioned in today's software marketplace. To be able to do process improvement, the organisation must have a process to improve from. These processes are commonly deviated from, and the PDU/PAY organisation at Ericsson AB has experienced that this happens too often within their organisation. The aim of this master thesis was to investigate why such deviations occur and how they could be prevented at PDU/PAY.

A survey including a qualitative and a quantitative part was conducted at PDU/PAY to investigate this issue. The result was that processes were often deviated from due to lack of: management commitment, user involvement, synchronisation between processes, change management, anchoring of processes, and communication of processes.

In addition to the conducted studies, an improvement proposal is given to the PDU/PAY organisation. This includes one organisational part and one part that is directly related to the actual work with processes. The proposal is intended to give PDU/PAY an essence of how to improve their work with their organisational processes.

Keywords: Anchor, Deviation, Process, Synchronise

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Chapter

1

Introduction

"I've observed that companies often abandon an official process in midstream because it's too difficult to describe and assimilate, relegating it to "shelfware" that sits unused in a manager's office"

Gary K Evans

The purpose of this chapter is to introduce this master thesis and the problem area and goals that it addresses. The chapter also introduces the outline of the thesis and gives reading guidelines.

1.1 Background

Software process improvement is something that is widely spoken about in today's software marketplace. Many companies are talking about that they have to improve their processes to become more competitive in terms of higher quality, higher efficiency and so forth. To be able to improve these processes, they need to have a process that they follow in the first place.

These processes are often manifested in process descriptions; usually comprising process-flow/process-network diagrams. It is also common that these carefully documented processes are intentionally or unintentionally disregarded or deviated from. Reasons may be that the process description may be hard to communicate well, or that different stakeholders, or persons, maintain their own private interpretation of the processes and how to practise them.

When there are deviations in the way people view or practise processes, several problems are encountered. First of all, money is spent on developing the processes that are not used. The processes also get hard to evaluate and measure due to that people and projects perform their work responsibilities in diverse ways. Evaluations of processes are important because it makes it easy to see whether changes that were enforced really improved the process or if they worsened the process. Therefore, the first move to continuous improvement is to get people to really use the organisations described processes.

The PDU/PAY organisation at Ericsson AB (further on called PDU/PAY) has found out that the requirements management process is not working satisfactorily. Therefore, a requirements management project (RM-project) was started in order to improve this process. A problem that is encountered when developing a process

(such as the requirements process) that affects several departments and sub-processes (e.g. design and test) is that the sub-processes must be fitted together. This means that all sub-processes must agree with the process that is developed/improved. Within the context of the RM-project, this thesis project was conducted in order to see the reason for why processes are not followed as intended and how the different sub-processes could agree upon a process that affects them all. Further, the thesis discusses how these deviations from processes can be avoided.

1.2 The Company

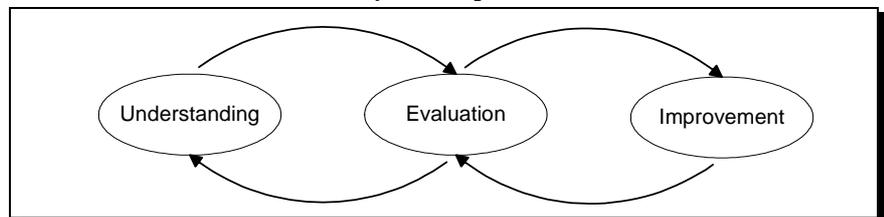
PDU/PAY is an organisation within Ericsson AB. PDU/PAY develops software solutions that make it possible for mobile operators to charge their customers in real time for the services they offer. Most of the about 600 employees are working in different software development projects. Such projects typically include 60-120 persons for 12-18 months. The departments/units from which the staff come from differ during the lifecycle of a project, but 60-120 persons are most of the time active within the project.

The processes at PDU/PAY today are mostly developed within each department or unit (e.g. a design unit has a design process) and they also have some standard processes that all departments should follow (e.g. a process for inspecting artefacts). In addition, the organisation follows a standard Ericsson process for project management (PROPS) within the projects.

1.3 Problem Description

Today's problem at PDU/PAY and many other organisations is that they do not fully understand their described work processes. In order to succeed with an evaluation of a process, the first step is to understand what they actually are doing. When a company has this understanding, they are able to evaluate their process and then improve the process where it is needed, this is explained in Figure 1-1.

Figure 1-1: The improvement process comprises three different stages. The first is to understand the process, the second is to evaluate current work and the last stage is to improve this way of working. When an improvement is made, the improvement must be evaluated and understood in order to start a new cycle of improvement.



The first step to be able to understand the process is that the company works the same way repeatedly project after project. Today at PDU/PAY, the requirements process differs between each project. Thus, when suggesting and implementing changes in the requirements process, they cannot be certain if the potential improvement was due planned change itself, or if other factors influenced the improvement. This is explained in Figure 1-2 and Figure 1-3.

Figure 1-2: The problem at PDU/PAY today is that the requirements process is not commonly understood and it differs too much between each project. This way they have no stable base to evaluate the changes from.

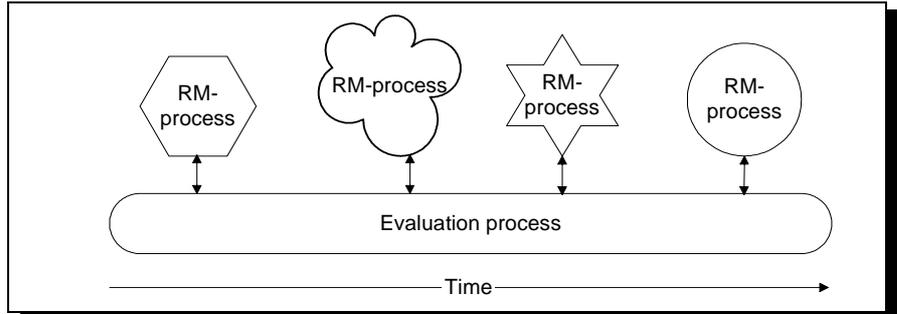
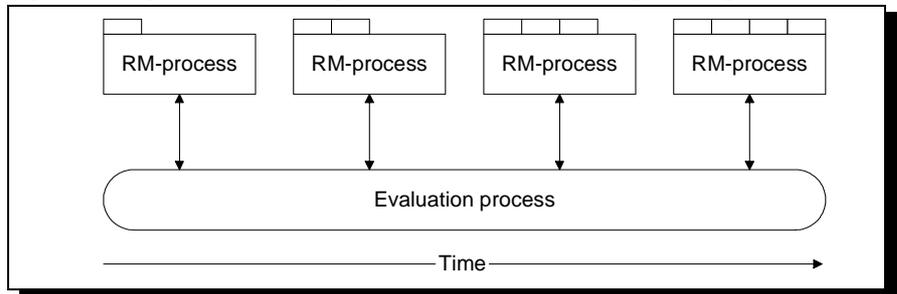
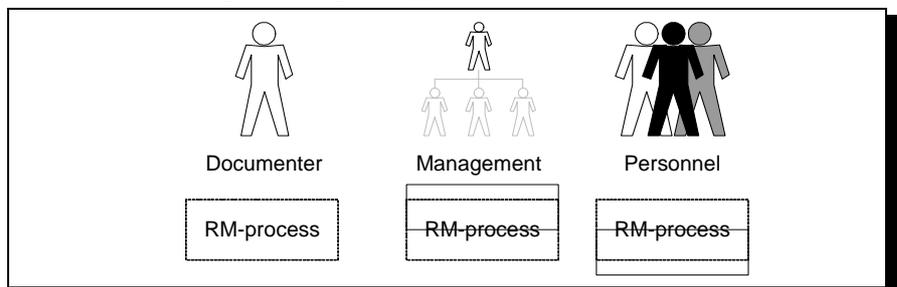


Figure 1-3: With a stable process that are repeated in each project PDU/PAY could evaluate the change that is enforced against the process baseline and hence see if the changes improved the process. If so, it is possible to establish the change in the process baseline.



One of the most challenging problems within this area is to get all personnel to understand the work that they perform so that it could be repeated without dependencies on key persons. Today, process descriptions are often interpreted differently by different persons as explained in Figure 1-4. This way, people do not actually know how they are supposed to work or they are not adopting the process because it is not anchored among the personnel.

Figure 1-4: The problem with different views in a project is that no one (except for the person that has documented it) actually has the whole picture of the process. Hence, they are not working according to the description. In the figure this is illustrated by the difference between management and personnel but the differences are also valid for differences among the personnel or management. (Striped line is the documented process and filled line is the view of the particular person(s)).



1.4 Goals

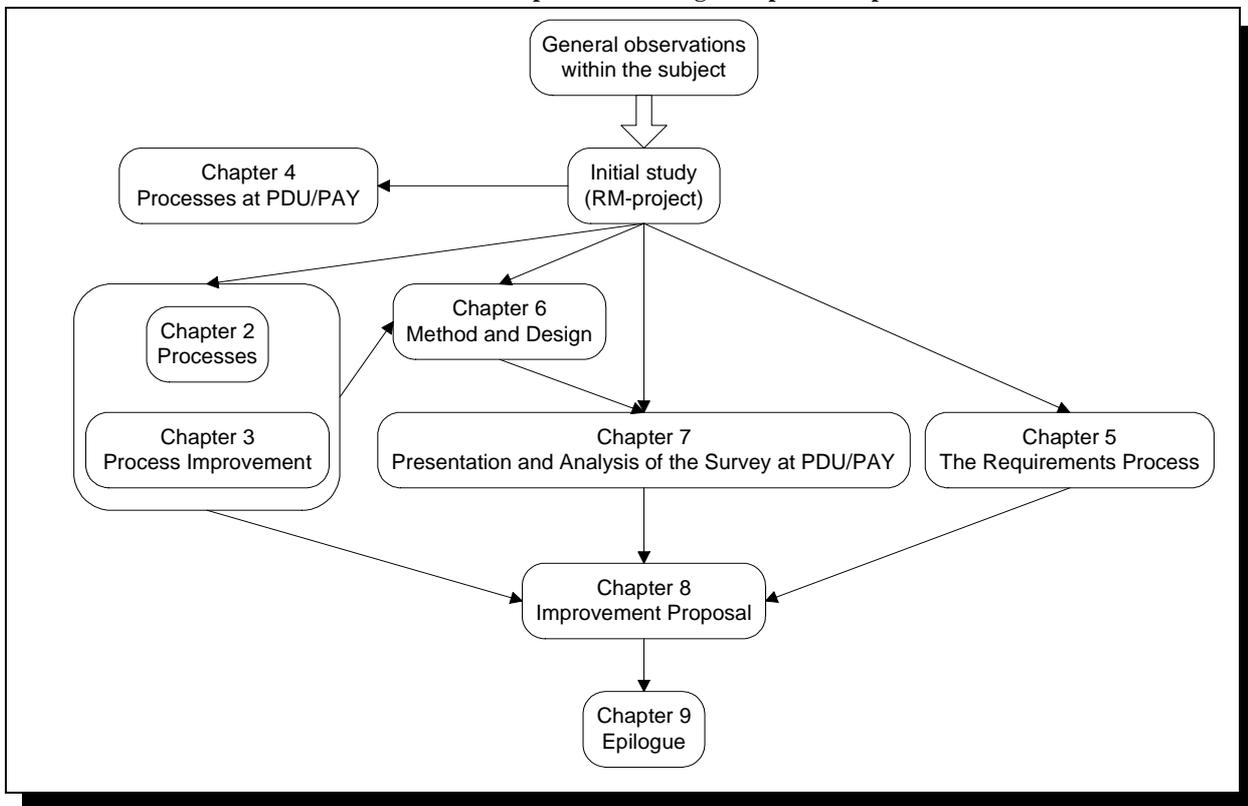
This master thesis is of an explorative nature and aims primarily to get an understanding of the problems encountered at PDU/PAY. From the discussion made in 1.3, the following goals for the thesis are derived:

1. Investigate if and in that case why the deviations of a process occur.
2. Investigate and give a suggestion to how processes can be understood and explained in order to get staff to use the described processes at PDU/PAY.
3. Investigate and give a suggestion on how to perform process related work in the future so that the staff could adhere to the described processes.

1.5 Structure of the Thesis

Figure 1-5 presents the structure of this master thesis. Below follows an explanation of each phase in the work and each chapter that is present in the thesis:

Figure 1-5: The structure of the master thesis that leads the reader to the goals stated in 1.4. The arrows that are present in the figure represent input.



1.5.1 General observations within the subject

This general observations lead to this master thesis in the first place. These observations were made both by the PDU/PAY organisation and by the author of the master thesis. The general observations were that PDU/PAY has a lot of documentation about the processes they shall follow, but they are often deviated from. Therefore, PDU/PAY wanted to know how to overcome this problem.

1.5.2 Initial study (RM-project)

This step of the work was conducted together with personnel from the PDU/PAY organisation. The aim with the project was to evaluate the current requirements process at PDU/PAY in order to be able to improve it. The first part of the RM-project (in which this master thesis was represented) was a number of interviews with staff from different departments at PDU/PAY. In these interviews, the interviewees' elicited the state of the current requirements process at PDU/PAY.

The intention with the participation in the RM-project was to understand how things are working at PDU/PAY today and get an understanding of which of the encountered problems that were related to processes. The information gained in these interviews laid a foundation for what to focus on, which literature to read (chapters 2 and 3) and which questions to ask in the quantitative study (chapters 6 and 7). In addition, the information was used in chapters 4 and 5 to explain the current work practises at PDU/PAY, both the documented practises and the way that they actually work. This provided valuable input for the further studies conducted within this master thesis project.

1.5.3 General Theory within the Subject (chapters 2 and 3)

These two chapters were intended to give the reader a background about the theory that exists in the areas the master thesis discusses. They are particularly important to readers that have a limited knowledge and experience in the software engineering field. They also describe best practices within the area today and also serves as a base for the questions that were developed within the empirical study.

1.5.3.1 Chapter 2: Processes

Chapter 2 describes what processes are and how they should be used. It further discusses common reasons for why there are deviations from the defined processes. The chapter also discusses how processes should be modelled and maintained successfully.

1.5.3.2 Chapter 3: Process Improvement

This chapter introduces the reader to the change of a software process. This change is intended to be an improvement and the process improvement lifecycle for successful process improvements are presented. This lifecycle brings up the critical steps an improvement should take and discusses what should be done in each step. Further, critical success factors in software process improvement and possible resistance factors are presented.

1.5.4 The Current State of Processes and the Requirements Process at PDU/PAY (chapters 4 and 5)

These two chapters describe the current work practises at PDU/PAY. These work practises are derived from the documentation that is available at PDU/PAY today and from the interviews that were made within the RM-project. These chapters are aimed for readers who have limited knowledge about PDU/PAY and their work practises regarding processes and the requirements process.

1.5.4.1 Chapter 4: Processes at PDU/PAY

This chapter introduces how process related work is carried out today at PDU/PAY. The chapter presents how processes are developed, maintained, documented and used in the organisation. It also presents how process improvements are suggested, evaluated and handled within the organisation.

1.5.4.2 Chapter 5 : The Requirements Process at PDU/PAY

This chapter describes how the requirements process at PDU/PAY is working today; both in terms of how it is documented and how it works in reality. The chapter also brings up the five most mentioned areas for improvement of the study. Note that the intention with this chapter is to introduce this current state and is no attempt of describing how requirements should be handled according to literature.

1.5.5 Empirical Study and Improvement Proposal (chapters 6, 7 and 8)

These three chapters are intended to readers who are interested about the result and how the result was derived in this master thesis.

1.5.5.1 Chapter 6: Method and Design

Chapter 6 comprises two parts. The first part discusses the theory of how to conduct empirical studies. The second part presents how the empirical study was designed in this master thesis.

1.5.5.2 Chapter 7: Presentation and Analysis of the Survey at PDU/PAY

This chapter presents the qualitative and the quantitative studies that were performed in this master thesis. The chapter also compares and analyses the result of the two studies in order to see how the findings corresponds to each other. Further, the chapter analyses how the findings in the studies relate to the improvement areas that were found in the requirements process.

1.5.5.3 Chapter 8: Improvement Proposal

This chapter discusses how the theories and studies result relates to each other. It also gives PDU/PAY proposal of how to handle process related issues in the future, based on the experiences gained through the project. This proposal is not intended to be a set of solutions that solve all the issues found in the studies. Rather does it provide an essence through which PDU/PAY could start to improve their process management.

1.5.6 Chapter 9: Epilogue

The epilogue concludes and evaluates the master thesis. It also discusses where further research is needed in the area.

1.6 Reading guidelines

1.6.1 Audience

The intended audience for this master thesis, are persons with some general knowledge in the software engineering field. The theory chapters give a foundation for the reader but it is recommended to have some background knowledge anyway in order to fully understand and take advantage of the theories and discussions.

1.6.2 Instructions

In order to make it easier for both the reader and the author, the following words shall be read as follows:

- He, should be read as he/she
- His, should be read as his/hers

1.6.3 Limitations

Some limitations have been done in this thesis in order to be able to produce it within the time of the project. These limitations are as follows:

- No attempts are made to improve the requirements process at PDU/PAY. The requirements process described in chapter 5 is a part of this thesis for example purposes.
- No attempts are made to improve the way PDU/PAY documents their processes. The pre-condition with this thesis was that PDU/PAY already had a notation and a way of documenting their processes (The process web, explained in 4.1).
- Possible inconsistencies in the thesis could be because of a major reorganisation that was made at PDU/PAY during the thesis project.

1.6.4 Definitions

In order to understand and take fully advantage of this master thesis, it is important that some definitions are clearly understood, and they are defined below:

- Process - a software process in terms of work methods, work procedures etc.
- Staff - (a) person(s) that use (or ought to use) process(es) in his/their daily work (i.e. software professionals)

1.7 Summary of chapter

This chapter introduced the reader to the master thesis and gave him an insight into the problem area that it addresses. Today, processes are not working satisfactorily at PDU/PAY. Staff abandons the official processes and hence the staff is working differently between the projects. The purpose of this master thesis is to investigate why the staff does not follow the described processes and how PDU/PAY could develop processes in the future that the staff adheres to. Further, it gave the reader instructions on how to read and follow the structure and content of the thesis.

Chapter 2

Processes

“The quality of a software product is largely determined by the quality of the process used to develop and maintain it”

Capability Maturity Model (Paulk et al. 1995)

The purpose with this chapter is to introduce processes to the reader. First, an introduction of what processes are and what factors that cause resistance against processes is made. Second, a discussion about why processes are not followed as intended and why people do not see processes the same way, is presented. Third, issues in modelling/documenting the process are discussed. Finally, maintenance of processes is shortly mentioned.

2.1 Processes

The Capability Maturity Model (CMM) defines a process as: “A process is what people do, using procedures, methods, tools, and equipment, to transform raw material (inputs) into a product (output) that is of value to customers” (Paulk et al. 1995). Hence, processes are the medium for holding the pieces of a development activity together and integrate people, tools, and procedures (Paulk et al. 1995). Process oriented thinking is something that is natural to mankind; people generally want to replace chaos with order (DeMarco and Lister 1999). Therefore, process oriented thinking also should be natural in the software industry.

The information that people generally want to extract from a process, is according to Curtis et al. (1992):

- what is going to be done
- who is going to do it
- when and where it will be done
- how and why it will be done
- who is dependent on its being done

This way, a structure and communication channel as help for carrying out the work is made. Processes makes a good foundation for creating an organisation that share the knowledge between the workers. It also captures lessons learned from earlier made mistakes within or outside the company.

When processes are introduced and followed, the processes make the organisation less dependant on specific individuals and it minimises the impact of staff turnover (Ferguson *et al.* 1999). Commonly shared processes also support people to move within the organisation, either to try new work responsibilities or to be promoted. Further, processes helps the staff to see the overall direction for the business and staff get an enhanced understanding for their own role as well as for others in the organisation (Steltzer and Mellis 1999). Gilb (2002) argues that people who understand the overall direction, tend to make good local decisions, which implies that only the critical few decisions must be made at the top.

According to Marciniak (1994a), the most serious problems in software organisations today typically concern organisational procedures and cultural behaviour. These things are not something individuals within the organisation generally can fix themselves. Therefore, a comprehensive and long-term focus on the software process is required to solve these problems (Marciniak 1994a). Further, to compete well in today's marketplace, it is a pre-condition to have best-practise engineering standards in place, measuring the conformance, and continually trying to improve (Gilb 2002).

According to Humphrey (1997), the purpose of process management is to provide the kind of disciplined environment needed for advanced technical work. In software development an interface error, a lost test case, or an uncontrolled program library can delay detection and repair of defects, increase costs, and delay schedules (Humphrey 1997). Process management help control such problems by providing a early and precise understanding of what is wrong, at the time when fixing the problem is most effective (Humphrey 1997).

2.1.1 Resistance against Processes

One of the largest resistances against processes in software development is that it stifles creativity. This often is derived from that people feel that processes are overly structured or implies too much control. This criticism is well founded; software development is not like mechanized or discipline manufacture. Instead, it is a creative profession, involving a lot of human and social interaction (Conradi and Fuggetta 2002). Hence, software processes must be developed so that they are not stifling creativity and flexibility and still enhance products with a rational way of working (Pfleeger 1998; Glass 1995). This also implies that processes shall be used in consulting style rather than prescriptively. (Becker *et al.* 1997)

Another large resistance factor is that users feel that others have decided how they shall work (Conradi and Dybå 2001). This often implies that the people who has documented it idealises the process as they wish it actually were. With this approach, the processes are taken out of the hands of the employees, where they belong, and they are being forced to use something that they do not own (Russo 1997). People often appreciate someone paying attention to their processes but they do not like to get straight jacketed (Becker *et al.* 1997). The only rational way to solve this problem is to incorporate the people into the development of processes (which is discussed later), it is very important that the staff see themselves as the owners of the processes even if a process group manage the process (Becker *et al.* 1997).

Further, processes are sometimes seen as a way for management to centralize thinking so that all meaningful decisions are made by the people who develops the processes, not by the staff assigned to do the work (deMarco and Lister 1999). This

implies that staff could get the message that they are not smart enough to do the thinking. Further, DeMarco and Lister (1999) have developed a list of resistance factors, and state that staff sees processes as something that:

- introduces paperwork (build papers rather than work)
- standardises methods (standardise one way and all other ways are wrong)
- creates absence of motivation (management thinks that personnel is incompetent)
- creates absence of responsibility (the fault is within the process, not the people, people wants responsibility)

These factors implies that staff becomes afraid of loosing their jobs, because they think that process is intended to design humans out of the systems, rather than into them (Conradi and Fuggetta 2002). Further, these factors are of course not entirely founded without a reason. If process management is performed in a poor way, these arguments could absolutely be well founded. Nevertheless, if process management were performed in a rational way with the right attitude, these arguments would not even be raised.

The following discussions in this thesis are aimed at investigate how process management should be performed to really take advantage of the concept of processes. The general philosophy in these discussions is that *“The process is here to serve you; you are not here to serve the process”* (Evans 2001).

2.2 Process Deviations

As discussed above, defined and documented processes could be a valuable help in daily work. Nevertheless, several authors have discussed problems when these carefully defined and documented processes are not followed in reality (e.g. Conradi and Dybå 2001; Wiegers 1999a; Cook and Wolf 1999; Curtis *et al.* 1992). This might be caused by several factors and Curtis *et al.* (1992) has developed a list of factors that might be the reason for deviations between the model and execution of a process:

- processes are developed prescriptively (2.3.1) at a too high-level that is unrelated to actual project activities (a process utopia is described rather than a description suited to the needs of the users)
- the described process are imprecise, ambiguous, incomplete, incomprehensible, or unusable to be performed in the project
- the documentation are not updated as the processes change

A common problem arises when someone writes a process description that everyone shall follow. The result becomes that the description gather dust in a shelf, rather than help people perform their work or changing the way they work (Wiegers 1999b). The main issue is that if the description is not understood, respected and demonstrated to be useful, adherence to the description cannot be expected (Conradi and Dybå 2001).

Developing unused processes is not only a waste of time, it is also dangerous when thinking the work is performed in one way but in reality it is performed in a different way. In such case, it might even be better not to have any process descriptions at all. Conradi and Dybå (2001) is highlighting the problem; *“People are typically*

viewed as performing their jobs according to formal job descriptions, despite the fact the daily evidence points to the contrary. They are held accountable to the map, not the road conditions”.

The question is whether the model or the actual work is the correct way of working. Validation of the process can be valuable to measure the adherence to the defined process (Cook and Wolf 1999). From such a validation, it could be decided whether the problems lies in the model or in the execution of the process. Additionally, a pro-active method could be used to evaluate how well a process will fit into a specific environment (Pérez *et al.* 1994 cited in Cook and Wolf 1999).

2.3 Modelling the Process

If we do not have the previously discussed processes documented in some way, it is hard to know that they are repeated continuously and deviations are avoided. Documenting processes are called process modelling and Curtis *et al.* (1992) argues that modelling the process:

- facilitates human understanding and communication of the process
- support process management and continuous process improvement
- facilitates automated guidance and execution of resulting process descriptions

However, it is important to remember that the model itself is not a process. It is only a process when the activities in the model are performed. (Paulk *et al.* 1995). Hence, the model is a representation of the process that should be used as a guide for the employees in their work. Curtis *et al.* (1988) performed a field study of 17 large projects, they concluded that using an agreed upon and commonly shared process model is a major factor of development effectiveness.

When modelling the process, there are two different ways to model it (i.e. prescriptively and descriptively). In theory these should be the same, but in practise they often are not. Actually, a third way is possible and it is proscriptive modelling. This technique describes the behaviour that is not allowed, but this is most often used as an complement to prescriptive or descriptive modelling (Curtis *et al.* 1992), and will not be further discussed in this master thesis.

2.3.1 Prescriptive Modelling

A prescriptive process description implies that the process should be performed in a particular way. Such a description, could for example be developed by a manager that describes how employees should work. This way, the description just reflects how the author consider the work should be performed and it is not anchored in the organisation.

The problem with prescriptive models is that their fitness (i.e. the degree of which it can be followed by the process users) in the organisation often is low (Curtis *et al.* 1992), and it is a kind of process utopia. Hence, when modelling prescriptively, it is likely that it facilitates discrepancies in the process views (2.2). Therefore, using prescriptive modelling as a base for process improvements (chapter 3) is dangerous. It is dangerous because basing measurements on a prescriptive model that is not followed, could imply that the resulting measurements can show the opposite of the actual effect of a change. (Curtis *et al.* 1992; Becker-Kornstaedt 2000).

2.3.2 Descriptive Modelling

Descriptive process modelling is a description of the software process as it is currently performed, and it is a key activity in process engineering (Becker-Kornstaedt 2000). The concept behind this modelling is to “*say what you do and do what you say*” (Russo 1997). The quality criteria for a descriptive model is its fitness (i.e. the degree of which its reflect the actual process)(Becker-Kornstaedt 2000). When using descriptive modelling, process improvements (chapter 3) can be measured according to the actual process. Therefore, process improvements based on a descriptive model can be made as changes to the process baseline. These changes are likely to be the most successfully absorbed by an organisation (Curtis *et al.* 1992). However, to be able to model a process descriptively, information about the process must be elicited.

2.3.2.1 Eliciting Information for Descriptive Modelling

The elicitation of a descriptive process model might seem trivial because it is just to define the current state of the process, but it is not (Humphrey 1989). One might think that it is just to collect all personnel and let them describe the process. However, there are many constraints when elicitation of a process should be conducted in industrial practice. Examples of such constraints could be: limited availability of personnel, personnel distributed over geographical areas, personnel can not articulate or do not know how the work is performed, and so forth (Becker-Kornstaedt 2000).

Another major concern in the elicitation of process information is that knowledge about the problems is scattered between different departments (Becker-Kornstaedt 2000), which makes it necessary to collect information from all involved departments to get the full view. The problem is that different departments often have different work languages, dress codes etc., and collaboration in-between the departments could suffer (Kock 1997; Diettrich 1998). In this case, it is hard to achieve a Win-Win relationship, i.e. equal opportunities for all participants in order to prevent domination from one perspective. In a Win-Win relationship, it is possible to make all stakeholders winners instead of just the most dominating one (Covey 1989; Karlsson 1998; Diettrich 1998).

There are several ways to elicit the information needed when modelling a process descriptively. Other areas (e.g. requirements elicitation) have encountered the same challenge and it is possible to learn from those. Techniques that might be interesting for eliciting process knowledge are (Becker-Kornstaedt 2000):

- *Artefact and document analysis*, collecting information through analysing documents and artefacts that are present in the process (project plans, deliveries etc.)
- *Interviews and group discussions*, eliciting knowledge from the future users of the model (i.e. people that are working in the process today)
- *Observations*, observing people performing their work

According to Becker *et al.* (1997), elicitation of process knowledge means investments for two reasons: 1. The elicitation process is time consuming. 2. The elicitation and modelling of the process often triggers additional changes since inconsistencies, redundancies etc. are found in the process. This requires even more efforts from the organisation. Hence, the better the process is understood by modelling it, the more likely it is that it will be changed (Becker *et al.* 1997).

If the modelling is not intended to involve everyone in the organisation, it is important to identify key stakeholders that have the ability to represent the department,

team or group. This stakeholder should be someone that have influence at the department, and could communicate the department's opinions from all levels.

2.3.2.2 Documenting the Process

There are several different modelling languages available to model the process that is elicited (Curtis *et al.* 1992). An explanation of these models is left out of the scope of this thesis because it is not relevant for the further discussions. Nevertheless, some consideration when it comes to how to write and level of detail of the process are presented below.

Researchers within the field agree about that the documentation shall be easy to read (no more than a page), and not too formalistic but rather useful and necessary. If it is not considered useful; do not bother to produce it in the first place (e.g. Russo 1997; Gilb 2002; Conradi and Dybå 2001; Becker *et al.* 1997). The main reason is that no matter how good the process elicitation is, people do not consider to use it if they cannot understand the documentation or if it is too extensive.

The level of detail of a process is much dependant on the people who will use the documents and how complex the task is (ISO9001 2001). More experienced people need a higher level of detail than less experienced people (Conradi and Dybå 2001; Curtis *et al.* 1992). For example, an experienced worker might just need a checklist to see that he has not forgotten anything, while a less experienced worker might need more specific guidelines. Further, the level of detail also affects the level of formalism introduced in the process, a larger level of detail provides more freedom to own decisions and creativity. Therefore, different levels of detail are desirable to satisfy the needs of all the staff (Curtis *et al.* 1992).

In this discussion, it is important to know that studies has shown that the most productive scientists are those whom management gave a moderate degree of freedom (Pelz 1966, cited in Humphrey (1997)). Therefore, the models should not be formulated too rigorously; software professionals are smart, and need some degree of freedom (Russo 1997). Focus should first and foremost be on defining the output that is wanted, and then give the staff progressively more discretion on how to produce it (Humphrey 1997) The most important thing to remember is that processes shall impose consistency and structure. Processes could be very flexible when the level of detail is right. For example, a process could require that design comes before coding but allow many different design techniques to be used (Pfleeger 1998)

2.3.2.3 Verification of the Process

When a process is elicited and documented, it must be verified so that it really reflects the current way of working. Personal interpretations by the documenters might (probably will) cause that the model does not reflect the current process after all. Therefore, a review of the model must be made. This is preferably made by the people that are going to work according to the model (Becker *et al.* 1997).

If the reviews shall be efficient, they must be specified to roles. This means that the stakeholders are just reviewing the parts of the process in which they are involved. This makes the reviewers more focused at the review procedure because they are interested in the result. (Becker *et al.* 1997). A last thing to remember about the whole modelling procedure is that "*The 'better' the outcome of process elicitation, the less rework is necessary*" (Becker-Kornstaedt 2000).

2.4 Maintenance of Processes

One of the most important things to consider in process management is to have a great change management procedure with a painless revision process that encourages employees to initiate changes (e.g. Conradi and Dybå 2001; Gilb 2002; Russo 1997; Humphrey 1995). Without that, the processes will not be followed due to as more experience is gained, the work methods will change, and the process description must reflect this change and preserve the gained knowledge. The process must also be easily tailored to local circumstances (Gilb 2002).

This kind of changes just aim to polish the process descriptions at parts that have shown to be better performed in another way than the current process descriptions. When possibilities for improvement are found or larger changes are needed, a process improvement project might be needed. Process improvements are discussed in the next chapter.

2.5 Summary of Chapter

This chapter introduced processes as something that integrates people, tools and procedures. Processes are also a medium for organisations to share knowledge between their staff. Although processes seem to be good for companies, staff often have resistance against them because they see them as formalistic procedures that make their work harder. A common reason to why people have resistance to processes and to why people sees them differently is that wrong persons develop the descriptions, they are not fit for purpose and they are updated too seldom.

Modelling the process is important if deviations shall be avoided and if the process shall be repeated continuously. There are two different ways to modelling processes; prescriptively and descriptively. Descriptive modelling is a description of the process as it is currently performed. Eliciting the information in a descriptive model is based on trying to get everyone's view of a process in order to get as reliable process model as possible. This could be performed through several different techniques such as interviews or observations.

When this information is elicited, it must be documented. When documenting the process, it should be easy to read and understand, and not too formalistic. It is also important to have a level of detail that suits the staff that it is aimed for. Finally, the process description must be reviewed; this is preferably made by the people who shall use it.

Chapter 3

Process Improvement

***“It is not necessary to change.
Survival is not mandatory”***

W. Edwards Deming (1900-1993)

The purpose of this chapter is to introduce process improvement to the reader. The chapter presents the process improvement lifecycle which is explained step by step together with the activities that shall be performed in each step. Further, the chapter presents a study that has been made over the critical success factors in software process improvement. Finally, the chapter discusses the problems with human’s natural resistance to change and how that is related to process changes.

3.1 Changing the Software Process

When having a process in place, process improvements can be carried out to improve the process. The intention with improvements is to learn from mistakes and continuously improve. Sten Trolle (Trolle 2001) once said *“You live as long as you learn”*, this is definitively applicable in software processes; as long as we learn from our mistakes and try to improve, we will stay in business. However, changing is not easy, there are several factors that must be accounted for and the change must be accepted throughout the organisation. To get this acceptance, it is widely recognized that the organisational culture must also change (Ibrahim and Hirmanpour 1995).

Therefore, a foundation for the change must be provided. Primarily, it must be accepted to fail. If failing is not permitted within an organisation, no one feel safe enough to propose a change because the fear of degradation if it was not an improvement (De Marco and Lister 1999). Secondly, fire-fighting rewards should be eliminated and replaced with rewards based on long-term improvements. Many organisations rewards fire-fighting; hence, people do not see any gains for suggesting and adhere to long-term improvements (Humphrey 1989).

When this foundation is provided, it is important to know that improvements do not come for free. In order to take advantage of the gains (Curtis (1994) argues that companies could achieve 5-10 to 1 returns on investment) of an improvement, the organisation must be willing to pay for it. Research has shown that organisations spending less than three or four percent of their budget on process improvement

(including training, consultants, work groups etc.) are dabbling. Organisations that spend seven or eight percent are pretty serious and those who are spending more than ten percent indicates major commitment (Wieggers 1999a).

Therefore, it is necessary to estimate how much today's process-shortcomings cost. Costs could be: blown schedules, overtime, high product support costs, lost new product opportunities, unsatisfied customers, missing functionality, personnel turnover cost, or low morale (Marciniak 1994a; Humphrey 1989). These costs shall be compared to the expected gain of the improvement.

When process improvement efforts does not work, it is most often related to knowledge and training issues. Common reasons for not working process improvements are for example (Wieggers 1999b; Ibrahim 1993, cited by Ibrahim and Hirmanpour 1995):

- Lack of time
- Lack of knowledge
- Wrong motivations
- Dogmatic approaches
- Insufficient commitment
- Lack of awareness and understanding
- Inadequate training
- Misunderstanding of the importance of process improvements.

Tom Gilb (2002), stated that “*the only thing that should not change is a great change process*”, based on that statement, it seems essential to create a change process that works with these factors in mind. Therefore, the following discussions aim to provide the reader with knowledge about how this problems could be avoided, and how to manage process improvements effectively.

3.2 The Process Improvement Lifecycle

There are some existing standards on *what* to improve in an organisation (e.g. Paulk *et al.* 1995; ISO9001 2001), but it has for long been questioned for standards focusing on *how* to improve processes (Stelzer and Mellis 1999). However, there are much literature that discusses how to conduct improvements (e.g. McFeely 1996; Deming 1986; Mansir 1989, cited by Ibrahim and Hirmanpour 1995). The problem is that these authors have rather diverse opinions of how it shall be conducted. Nevertheless, it is possible to see a pattern of the critical steps in improvement programs and these steps serves as a foundation for the following model of process improvements.

3.2.1 Set the Stage for Process Improvements

The first stage of the improvement cycle is to select an improvement team and train them in the activities that they are going to perform. (Mansir 1989, cited in Ibrahim and Hirmanpour 1995). The names of the roles differ in the literature but the structure is more or less the same. The following roles are identified as stakeholders of the improvement process:

Sponsor: This is a senior management role and he provides resources and official banking to the improvement initiative (Humphrey 1989). It is important that this person really believes in the improvement initiative. He must have a lot of courage to stick with the original convictions when schedules are slipping, members are discouraged, and the budget is nearly exhausted (Humphrey 1997).

Champions: The champions initiate the change process, they also lead, co-ordinate and drive the improvement activities. The champion should have a broad and detailed understanding of process management tools and techniques (Dale and Bunney 1999). Further, he shall maintain the focused drive in spite of all doubters and motivate the team. Studies have shown that without a champion, new ideas have a little chance of success (Humphrey 1989)

Change agents : The change agents lead the planning and implementation of the improvement initiative and are a part of the team that is presented below (Humphrey 1989).

Process users: Process users are the staff who are going to take advantage of the developed or improved process.

Software Engineering Process Group: The process group is formed to have a team dedicated to the improvement activities and the members should serve as specialists and facilitators (Humphrey 1997). The group should ultimately be staffed with two to four full-time members per hundred software professionals in the organisation (Humphrey 1997).

The roles described above have a great responsible in the improvement effort and it is important to choose the right persons for these roles. Becker *et al.* (1997) concluded that it is very important to involve all stakeholders from the beginning of an process improvement effort and the dedicated persons in the process group must be able to motivate and inspire the stakeholders to get them involved.

One question that always is discussed is whether to have process staff from inside or outside the organisation. Several authors (e.g. Humphrey 1997; Becker *et al.* 1997; Humphrey 1989) argue that the best solution is to mix inside and outside personnel. Inside process-staff have the organisational knowledge that probably will be needed, and outside process-staff have no predetermined thoughts about the process; hence, they are more objective. Outside staff also have a greater chance to get the confidence of the personnel in order to get correct information about the problems (Becker *et al.* 1997).

The confidentiality aspect is very important in order to get the information needed. Therefore, it is important to let the staff know that neither process or the humans will be judged, if not, they will not tell the truth but rather say what management wants to hear (Becker *et al.* 1997). If information about how the process *should* be performed were of interest, it would have been much easier to ask the management directly about how the process is working and what improvement must be made (Humphrey 1989). The key point is that the process staff shall be open-minded according to the process and respect the people they are dealing with.

3.2.2 Select a Process to Improve

When doing an improvement, a process to improve must be selected. When selecting a process: opportunities must be identified; major problems and root causes

must be prioritised, chosen, and identified; and measurement points must be identified (Mansir 1989, cited in Ibrahim and Hirmanpour 1995). However, in an industrial setting, it could sometimes be hard to select which process that is in most need for a change. Therefore, the process to improve might not be selected until the baseline of the process is set (3.2.4).

3.2.3 Baseline the Process (Where are you now?)

Baselining the process is one of the most important steps in process improvement based on the fact that baselining is the most mentioned step in the literature. The reason for baselining is to learn how the process currently is performed (2.3.2), to identify its major problems, and to provide a process baseline based on this knowledge (Ibrahim and Hirmanpour 1995). This baseline also serves as a metrics baseline when measurements shall be conducted in order to see how the future improvement affects the quality, productivity etc. (Ibrahim and Hirmanpour 1995). If not having this baseline, the organisation will never know if a change was an improvement, or just a change; *“it is not enough to know where we are going, we must also know where we are”* (Olsson and Runeson 2001).

Baselining the process is often good because *“most organisations are not suffering because they can’t solve their problems but because they won’t see their problems”* (John Gardner, cited in Humphrey 1989). This problem is often solved by baselining the process due to the enhanced understanding of the work methods. It is possible to know something without do anything about it, and it is possible to do something without knowing anything about it. Hence, the current process must be known in order to do process improvement in a rational way (Ibrahim and Hirmanpour 1995).

The establishment of a baseline is conducted descriptively as discussed in 2.3.2, with the staff involved. From this stage and forward, the staff should be involved in the work with processes. When the baseline is established, the changes must be gradual (Humphrey 1997) and accordingly is it possible to build the new improved process on top of the current. This, rather than installing an entirely new process, keeps the organisation from being disoriented during the future change (Curtis *et al.* 1992).

3.2.4 Develop a Vision of Desired Process and Identify Problems with the Baselined Process

When the process baseline is set, it is easier to find weaknesses within the process as it is currently performed. To prevent that the improvements just becomes another paperwork in the shelf, it is important to find the right areas to improve. Wiegers (1996) argues that to fully take advantage of the improvements, it is important to select those areas that yield the greatest long-term benefit. It is also important to focus on adding value to the business rather than trying to enforce someone’s notion of process utopia (Wiegers 1996).

Wiegers (1999a) states that it is important to be aware of that pain is the best motivation for changing the way people work (i.e. select those areas where the users encounter the most problems). O’hara (2000), aligns to this statement and add that everyone must achieve some benefit of the change that help them to do their jobs better, rather than seeking compliance to a specific model.

To find the right areas to improve, it is important that the personnel sees the problems and are committed to solve them. This must be reached through consensus between the stakeholders. To achieve consensus, each person must understand the decision, has had a chance to express his view of the problem, and state willingness to support the decision (Ibrahim and Hirmanpour 1995). Therefore, negotiation, where someone must surrender his opinion shall not be done; this person will probably not adhere to the new process.

The approaches to find such problems could be similar to those explained in 2.3.2.1. Further, techniques such as Pareto Diagrams (frequency or effect of problems), Cause-and-Effect (analyse the characteristics of a process situation and the factors that contributes to them) or Force Field Analysis (analyses the opposite conditions or situations) could be used to find the process-related problems and which factors that might contribute to them (Ibrahim and Hirmanpour 1995)

The most important thing is not which of the techniques that are used but to have the right personal skills. The staff that are going to use the process must be asked about their problems and their solutions to the problems. These people know their problems very well and are the best source for finding solutions (Humphrey 1997). When asking them, it is important to not complain about their current way of working, but instead celebrate their skills and experience as the valuable source of information it is. Just pointing out problems makes them feel bad about themselves and they will not attempt to improve (De Marco and Lister 1999).

3.2.4.1 Technology or Processes as a Vehicle for Improvement

A problem in the area of software process improvement is whether to implement new technologies (tools etc.) and tailor the process according to the tool, or to focus on the process itself and then choose appropriate technologies to support this process. Several authors (e.g. Curtis 1994; Brooks 1995; Humphrey 1989; Curtis *et al.* 1992) have addressed this problem, and they all agree that people in crisis rarely use their tools well and that human and organisational factors are at least as important as technological.

However, tools can provide much benefit when improving processes. In fact, it is vital for long-term improvement, but if it shall be effective, it must be built on a well-managed software process (Humphrey 1989). Therefore, focus should be put on defining the processes, and select tools and methods supporting these processes (Curtis *et al.* 1992). Often, when software professionals are asked about their key problems, few even mention technology as a solution to their problems, other factors are often seen as more important (Humphrey 1989).

A common mistake is to introduce technology without having a clear picture of the problem. Technology cannot solve problems that are not precisely understood. Instead, most people will object on having someone else's solution to an undefined problem forced on them, which will create resistance to change in the long run (Humphrey 1989). Therefore, automation should certainly be used to resolve the highest-priority problems, but little effort should be wasted until a clear definition of the process application is available (Humphrey 1989).

3.2.5 Set Priorities and Goals (Where are you going?)

When the problems are found in 3.2.4, the next step is to prioritise the problems and set up goals for the desired end state.

3.2.5.1 Prioritise

Changes should be made in small steps, and even then, they must be tested and adjusted before widespread implementation. (Humphrey 1989). To be able to focus on the most pressing needs for the organisation, some kind of prioritisation must be made. The most important thing when prioritising is that focus should be put on the products and what the organisation contributes to the overall business and to the environment surrounding the company (Humphrey 1997).

When prioritising, the pareto principle is a good technique to apply. The pareto principle is the process of separating the vital few from the trivial many (Marciniak 1994b). When applying this method, the organisation can focus on the problems that are most pressing to make the improvement as efficient as possible, and putting others into a queue that can be handled later. When conducting prioritisation, several factors must be accounted for (e.g. severity of problem, cost of fixing problem, cost of not fixing problem, and efficiency)

3.2.5.2 Set Goals

A Chinese proverb says: *“If you don't know where you're going, any road will do”*. This implies that setting goals is very important in process improvement; if the organisation does not know where they are heading it is impossible to create a strategy to get there (Humphrey 1989). Setting goals are ultimately conducted together with the future users of the process. This way, clear and meaningful goals will be stated, which will increase commitment and acceptance from the staff (Humphrey 1997; Weiss 2001).

When developing the goals, the organisation should focus on both today and the future (where are we now and where do we want to go?). The goals must be set carefully; if the change is too dramatic, no one knows how to start. Therefore, the change must be broken down to small and realistic increments (by prioritisation), with sub goals for each (Humphrey 1997).

When setting goals for the improvement, they should be SMART (i.e. Specific, Measurable, Assignable, Realistic, and Time based) in order to motivate the involved parties (Weiss 2001). The techniques to develop such goals differ, it could be done through brainstorming, workshops etc. but the key point to consider is to ask oneself (Potter and Sakry 2000):

- What is our goal?
- What is preventing us from reaching the goal? (the problem area)
- What other problems are related to this goal? (More problems that might be solved automatically, or are there other problems that must be addressed before solving this one?)

3.2.6 Develop a Plan to Accomplish the Goals (How do you get there?)

When goals of desired future state is set, a plan to reach the goals must be developed. Then, risk analysis are made, opportunities and problems are evaluated, critical success factors and metrics to measure achievement are specified, schedules and resources are attached, etc. (Ibrahim and Hirmanpour 1995).

One major issue that must be considered when planning the improvement is whether to launch or deploy the improvement. One of the main questions in this area is if the improvement should be introduced organisational-wide or if a pilot

project should be started? There is no silver bullet to this question; it depends on the extent of the change, size of organisation and so forth. Large organisations for example, can undertake several initiatives concurrently across multiple projects, even though each pilot project just focuses on just a few areas at a time (Wiegers 1999a).

The reason for focusing on just a few matters of the improvement is that if several new aspects are tried, there is too much noise in the process to see which generated the potential improvement. Therefore, one or a few new aspects shall be tried at the same time, but besides this/these, standards and regulations shall be followed as usual (DeMarco and Lister 1999). Minor adjustments in the process, might be introduced organisational wide. Most authors however, states that more extensive process improvements shall be made through pilot projects (e.g Steltzer and Mellis 1999; Humphrey 1989).

Further, Humphrey (1997) argue that in planning, it is important that the staff is involved. If the staff is involved, they understand the change and they see why it should be made and what to expect from it. This reduces the unknowns from the change, which helps to overcome resistance. Since resistance to a change is proportional to its magnitude, resistance can be reduced by breaking a larger change into smaller steps. Each step is then easier to sell and implement and total resistance is reduced (Humphrey 1997). Further, involvement of representatives from all departments concerned is important because the knowledge that is necessary to generate effective redesign proposals is unlikely to be possessed by a single department or manager (Kock 1997).

3.2.7 Implementation of Improved Process (Make it happen!)

When the improvement is planned, the actual implementation of the process should be conducted. This might be the most important step in the improvement cycle; if this is not done, nothing will really change (Wiegers 1999a). When implementing the improvement, the steps in descriptive modelling should be performed (2.3.2). The only difference is that problems and solutions to them (rather than current way of working) should be elicited, documented, and verified. When these steps are conducted, the description should be published and communicated to the staff. To really take advantage of the improved processes, the staff must be trained in order to use them most efficiently.

3.2.7.1 Training the Improved Process

Training the new process is necessary for the people affected. By training, they gain the knowledge that the process is changed, and they gain the knowledge of how to use the process most efficiently. Just as in soccer, the professionals in software development both need individual and team training.

Team training should provide the process-users with the knowledge needed to see the overall direction, which strategy the organisation has, which fellow workmates they have to interact with, and so forth, in order to share a common understanding . This could be compared with a soccer team, that have a common strategy of how to interact and how to perform a soccer match in the best way. At the same time, different roles need individual training as well. A tester needs training on test-process activities rather than design-process activities. This could be compared with a goal-keeper in soccer, who needs training in keeping the net rather than how to score.

Learning is most effective when it is in direct relevance to the affected staff member's needs (Humphrey 1997), therefore is it important that the training program are tailored to the different roles and not just a "one fits all" package. Hence, technology training (coding, design etc.) is more successfully gained trough individual training while process training is gained more successfully through team training (Hutchings *et al.* 1993).

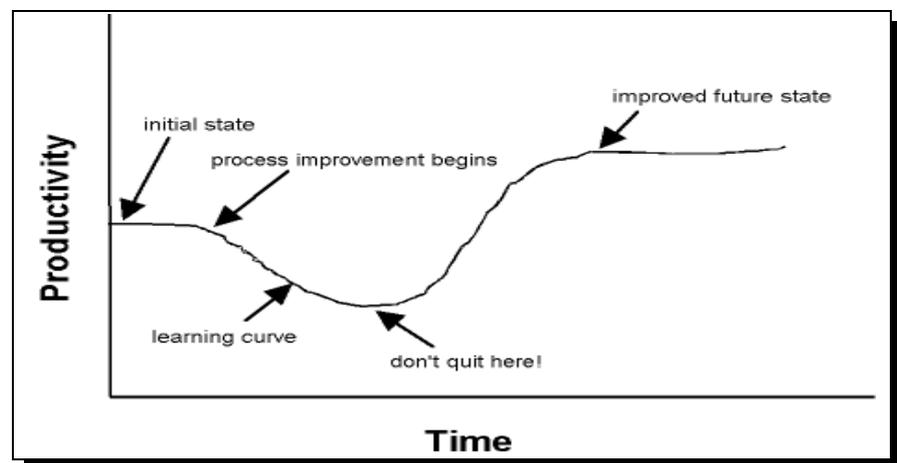
The purpose of the training should not be to drill the process into the people's head, but to give them a foundation in order to become encouraged to solve their own problems and to come back for advise when needed (Humphrey 1997). Therefore, is it better to train the personnel in process work than give them a process model to work from. It is like the distinction between learning a story and learning how to read (Humphrey 1989). This way, they are able to know when the processes should be applied or where they should be adjusted or replaced (Humphrey 1997).

Research about teaching methods has shown that lectures (presentations etc.) are the least efficient method (Johansson 2000). Studies have also shown that interactive learning is more efficient than content reading (Jones 1987). This indicates that alternatives to lecture based training should be used when suitable. Several techniques facilitate this kind of training (e.g. board games and role plays). The drawback is that they are relatively time consuming, but remember: "*Training is expensive, but not nearly as expensive as not training*" (Humphrey 1989), and with suitable techniques the training will be more efficient.

3.2.8 Measure the Result of the Improvement

When having a baseline to start from and the change is implemented, it is time to evaluate whether the change was an improvement or just a change. When the change is implemented, we can use figures from the baseline to compare with the figures of the changed work.

The learning curve (Figure) introduced with the change is important to consider. An improvement attempt is not a miracle that works directly, it takes time to learn new work methods and incorporate them into the organisation (Wiegiers 1999b). Therefore, it is important to know that even if the short-term results are dabbling, the long-term results might be great. The hard thing is to know when to measure; how do we know if the learning curve rises again or if the introduced change is that bad? The process improvement learning curve (Wiegiers 1999b).



Another thing that must be considered is that the process-baseline is followed. If it is not, the measures might only be present in the model but not in reality, which makes the measures non-accurate (Becker-Kornstaedt 2000). However, deviations from the process-baseline are not always bad. Deviations could be a new way of solving things that are better than the described way in the defined process. In such cases should the process be changed in order to share the new knowledge (Gilb 2002). If this deviations are not maintained properly, it would take much effort to baseline the process before each improvement initiative.

When considering what to measure, O'hara (2000) states that aligning Goal-Question-Metrics (Marciniak 1994a) to business goals is important for process improvement. Goal-Question-Metrics is an approach that focuses on the business needs rather than measures that are easy to collect (without saying that the measure derived from Goal-Question-Metrics cannot be easy to collect). As the name suggests, it is built upon three parts (Fenton and Pfleeger 1997):

- Goal - List the major goals of the project (in this case the improvement project)
- Question - derive question(s) from each goal that must be answered to determine if the goals are being met
- Metrics -decide measurement(s) that could answer the questions adequately

3.2.9 Redo the Cycle (What next?)

Wieggers (1999a) stated that "*Process improvement is a journey, not a destination*", and the key point is that improvement never stops. When the first improvement cycle is finished, it is time to start planning the next one. Marciniak (1994a) argues that Japanese industry has been successful for a long time, and the key element of the success has been the sustained focus on small incremental process improvements. The Japanese organisations started quality circles where users could discuss and develop improvement suggestions in order to enrol employees in the improvement effort (Marciniak 1994a). This way, they had a forum where people met and planned what to do next, and therefore continuous improvement were achieved. Further, they were able to seek opportunities for improvement, rather than waiting for a problem to reveal opportunities. This could be conducted either on a periodic basis (e.g. once a month), or as a post-mortem evaluating what worked well and what worked less well in a project (Humphrey 1997).

In other words, when the improvement cycle has come to this step, it is time to start over with a new increment of the improvement cycle. If the measures were not satisfying and it was no improvement, it is possible either to start all over (3.2.1) with a new area to improve or to start over with another strategy, based on the process-baseline (3.2.4). Hence, the evaluated changes are removed and the baseline is still valid.

3.3 Critical Success Factors in Software Process Improvement

When changing the software process, some factors affect whether the change will be an improvement or just a change. Steltzer and Mellis (1999) conducted an analysis of published experience reports and case studies of 56 software organisations from 11 different countries, which had implemented an ISO9000 quality system or had conducted a CMM-based process improvement. The authors compiled a list of 10 factors that they had elicited from literature research. Further, they counted how

many of the reports that considered these 10 factors as critical success factors for improvement programs. The list is presented below in descending order of importance by the collective rank from both the ISO9000- and the CMM-cases (those who have the same numbers shared the ranking):

1. Management commitment and support: Management must provide time, money and resources to the improvements; otherwise, they will not take place. Management commitment is also needed to overcome staff resistance; they must show that the improvement initiative is important, by attending meetings as well as actively participate in the work.

2. Staff involvement: The staff must adopt the innovations into their day-to-day activities; if they do not accept proposed changes the improvement initiative is useless. The staff have first hand experience of the processes' strengths and weaknesses and they must therefore participate in the development, rather than having an external group saying what to do. Staff members who contributes to the improvements are more motivated to adopt the improvements. To ensure this, successful programs have establish local process teams, special interest groups, training schemes, and forums for exchanging and coordinating efforts among project teams.

3. Providing enhanced understanding: Software development interacts with many other tasks in an organisation and these cannot be separated. Successful improvement efforts require a common understanding of the organisation's mission and vision by management and staff members. Management and staff documenting the process together will achieve enhanced understanding. It also encourages staff to accept changes as they will see why the improvements are useful.

3. Tailoring improvement initiatives: Usually, staff members refuses to work with manuals and documents that are developed for the entire organisation. Many problems in process improvement concerns minor details, tailoring helps to address these details and to fight the problems by implementing incremental changes. If staff sees the benefits of the transition, and they realize that the improvement efforts help them in their daily work; they commit to the improvement program.

5. Managing the improvement project: Process improvement without project management often leads to; ad hoc, inefficient, and sometimes chaotic practises. Successful improvement initiatives, ran the improvement project like a software development project with specified requirements, milestones etc. Further, successful improvement initiatives, tested the improvements in pilot projects.

6. Change agents and opinion leaders: Change agents initiate and support the improvement projects at the corporate level. They are individuals or teams, external to the process that is to be improved. Opinion leaders should be competent individuals responsible for initiating, guiding, and supporting the improvement at a local level. These are indispensable for overcoming the potential schism between software development activities and process improvement efforts.

6. Stabilizing changed process: Stabilising the changed process is necessary to avoid that the changed process slides back to the old habits. Staff members adopting a new process need continuous feedback, motivation, recognition, and reinforcement to stay involved in the improvement effort. They also need guidance and support to overcome initial problems and difficulties. Misunderstandings and weaknesses must be eliminated to ensure smooth functioning of new processes.

8. Encouraging communication and collaboration: Process improvement initiatives are often accompanied by rumours, fears, and resistance from staff members. Intensive communication helps to remove these barriers. Many teams and divisions in software companies suffer from inadequate cooperation with other groups. Collaborative projects include joint process descriptions, workshops, and special interest groups. Successful improvement programs have established effective interfaces of various teams. Close cooperation of business units provides natural feedback loops, enhances staff members' understanding and knowledge, encourages staff to exploit synergy, and consequently improve productivity and quality.

9. Setting relevant objectives: It is essential that staff members understand the relationship between the objectives of software process improvement and revenues, cash flow, or business result. Mere conformance to a standard, attaining certification usually is not a relevant goal for staff members but; "emphasize on productivity, quality, and cycle time. Avoid process for its own sake". With objectives decomposed to specific measures for project managers and programmers, everyone can see how individual and group efforts relate to the organisation's success. This helps to direct the efforts toward common objectives, and to motivate people.

10. Unfreezing the organisation: Social processes usually have an "inner resistance" to change. To overcome the resistance an additional force is required, a force sufficient to break the habit and unfreeze the custom. In successful improvement initiatives, employees understood the need for process improvement and management committed themselves to the software process efforts and hence provided momentum to the initiative and created realistic opportunities.

The factors that are described above might seem obvious. Nevertheless, these factors were according to the article's conclusions, described as lessons learned. The reason for this is not clear, but obviously many process initiatives and process improvement initiatives are failing. Keeping these factors in mind and really paying attention to them are thus important for successful improvement programs.

3.4 Resistance to Change

As seen in the discussions above, it is important to get staff to overcome the inner resistance to change. Common factors that contributes to resistance are that people generally fear the unknown (Wiegers 1999a), they do not want "experts" telling them how to do (Humphrey 1989), they do not want to become a novice on methods they have mastered for a long time (DeMarco and Lister 1999) etc. Another major resistance factor is the "not invented here syndrome" (Humphrey 1997), people often refuse to use methods that other people have developed. A way to overcome this resistance, except for the earlier mentioned ways, are to find people that have high influence over their fellow workers and are good at convincing others about the benefits of the improvement.

Including just anyone with high influence is not appropriate, but focus should be put on people at the right resistance level. The level of resistance differs between people and Jerry Johnson (cited in DeMarco and Lister 1999) stated that there is a pattern in this resistance, something he calls "Resistance-to-Change Continuum". This contains the following three resistance levels (in increasing order): blindly loyal, believers but questioners, and militantly opposed. Imagine the three different types of people in a map-road condition. Blindly loyal, turns left even if the road turns

right because of the map. Militantly opposed, turns left even if the map and the road turn right. Questioners, follow the road after considerations of which point of the compass he is heading and what the map says. Hence, focus should be put on convincing the questioners, in order to make a successful change.

3.5 Summary of Chapter

The intention with process improvement is to learn from the past and try to improve the processes in the organisation. However, changing is not easy, several factors must be accounted for and the change must be accepted throughout the organisation. This chapter introduced a process improvement lifecycle which aims to explain what steps that are critical in a improvement effort. First of all, some kind of process group must be appointed. Then, a process to improve must be selected, followed by baselining the selected process. When the baseline is established, problems with the baselined process must be identified and a vision of the desired process must be developed.

When this vision is set, the different improvement opportunities must be prioritised and then goals could be developed according to these prioritisations. Further, a plan must be developed for how to accomplish the stated goals. When this plan is established, the implementation and training of the improved process should take place. The implemented process must then be in place for learning before the process can be measured. When these steps are conducted, the cycle could be performed over and over again with new problems and opportunities.

Beside this lifecycle of process improvement, it is important to know which success factors others that have running improvement projects rank as the most important ones. A study conducted shows that management commitment and user involvement are the two single most important factors. Further, shared vision between management and staff, possibility to tailor the improved process, and how the improvement projects are run, are seen as important factors.

Another threat against successful process improvement is that people are resistant against change. Many persons are resistant against changes in areas that they feel that they have control of. It is important that people who run improvement initiatives are aware of that people who questions the ideas of the improvement team are the ones that they shall focus on extracting information from.

Chapter

4

Processes at PDU/PAY

"We learn from each other"

PDU/PAY guiding lights

The purpose of this chapter is to introduce how the process related work is carried out today at PDU/PAY. The introduction aims to provide the reader with enough knowledge to understand further discussions about suggestions for improvements that are made in chapter 8. The content of this chapter is derived from the documentation that is available at PDU/PAY today, RM-project interviews (1.5.2), and additional discussions/interviews with people that have good insight in process-related work within PDU/PAY.

4.1 Process Web

PDU/PAY is rather focused around processes; the organisation makes guidelines, flows, checklists etc. for how they are supposed to work. This work is not run by a particular group or department but rather distributed across the organisation. However, one department serves as a help and coordinator of the activities for people that work with processes. This department puts requirements on the processes regarding notation, standards etc. and these requirements have evolved into the "process web" (an internal web page that contains information about processes and process-related work). This web was created to collect and coordinate all the different process descriptions that exists in order to get a better overview of the processes.

4.1.1 Process Users (Staff)

The concept of the process web is to be able to go from the holistic view of the PDU/PAY business processes all the way down to specific processes used by specific roles within PDU/PAY. These business processes are structured so that management processes and operative processes are tied together in order for it to be possible to see the interfaces between the different processes.

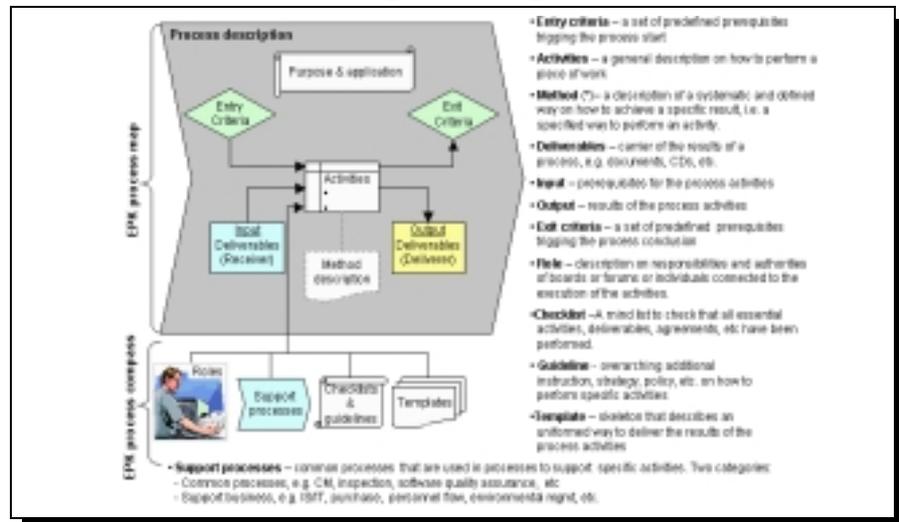
When a person enters the process map and has the whole picture of the PDU/PAY organisation, he can click himself through the parts in the flow until he reaches the sub process he is looking for. All the way through this navigation, it is possible to see which other sub processes that are related to "his" process.

4.1.2 General Process Guidelines for Persons that Develop Processes

The general guidelines aim to provide a foundation for what to think of when developing and communicating processes. The processes are divided into three categories: generic (high level principles), specialisation (line organisation adaptation), and project adaptation. The processes should be developed from generalisation and down to project adaptation. All processes, templates, guidelines etc. that are developed, shall be referenced from the process web and they shall be stored in a common database.

The documentation that is to be produced shall contain information according to the right column of Figure 4-1. There are also some rules of how the documentation shall look like. For example, there shall be no screen flows when using a screen of size 21" and there shall be no page brakes when printing. To avoid that these regulations are violated and to reach conformity, there are templates for how to develop process descriptions.

Figure 4-1: Issues that shall be documented in a process description



4.1.3 Usage of the Process Web

The web has been used for approximately 1 year and is regarded as important for the synchronisation of processes. A person from the department that administrates this web estimates that 60-70 percent of the present processes at PDU/PAY are incorporated into this web. However, this estimate is uncertain because of those processes that are not incorporated are not known to him.

Due to the fact that the web is rather new, the guidelines are not always followed as intended. Today, most focus is put on activities that guides people in their work. People argue that too little focus has been put on information regarding input-output or entry-exit criteria. This makes the requirements that should be present between departments or processes suffer, and departments have not always agreed upon these criteria. Today, the finishing process often defines the exit criteria without involvement by the receiver of the work results. This derives that there are no hand-shaking between the developer and the receiver of the work results.

A process documented at the process web often brings up processes in a general sense, and they are not tailored to certain needs. However, project personell are inspired to go through the processes in the beginning of a project to evaluate them. If they want to tailor these processes to their own needs, they should post an exception request to get the permission to change or disregard the process in this particular project. An exception request, handles temporary deviations from a process and is useful when users want to deviate from a process, without changing the standardised process.

Even if the process web contains much information about what parts that shall be present in a process, it does not contain guidelines about the level of processes or on which issue to focus (e.g. entry-exit criteria, templates, roles). This often depends on the person who develops the process and his opinion steers what is needed. This derives that the level of descriptions could be diverse and that some descriptions focus on checklists, some on activities, and some on entry exit criteria.

4.2 Processes

4.2.1 Involved Parties in Process-related Work

The people that handle the actual process-work are, as stated earlier, distributed throughout the organisation (which is a matrix organisation as explained by Nicholas (2001)). The work is mainly conducted by the “owner” of the affected process, together with some work group. The owner is a line manager responsible for a particular process (e.g. line manager for design department is the owner of the design process). The work group often consists of people that use the process in their daily work or by people that have good insight into the process. These persons, handle the process-work in parallel with their ordinary tasks and thus, the process-work sometimes suffers because of prioritisations.

Due to the fact that the work is divided throughout the organisation, people who handles processes are often not educated in doing these tasks. Therefore, these people must find information themselves at the process-web, on the Internet, or in books, in order to do a good job. This results in that the level and structure of the work somewhat differs.

PDU/PAY has also tried to hire professional consultants to perform the process improvement work. This has often failed because the hired persons has too little knowledge about the specific organisation. Therefore, the consultants have given complete solutions that are derived from literature or experience that are not shaped for this particular organisation. This experience has also resulted in that PDU/PAY has neglected to have a department that are handling all process-related work in the organisation.

4.2.2 Prescriptive vs. Descriptive

It depends much on the person who is responsible for the process work if the process is described descriptively or prescriptively (2.3). The philosophy at the department that is responsible for processes is that processes should be described descriptively, but unfortunately they are often described in a more prescriptive way. The problem is that people often describe both the way they work today and at the same time perform improvements towards a perfect process. A common problem is that the persons have too high ambition to develop an ideal process; hence, the jump

between the current and the ideal becomes too large. Therefore, people do not consider the described process relevant and neglect to adhere to it. The strategy to get the views of all process-stakeholders is often through the review of the described process (4.2.3). This is, as many other issues, dependant on the people who runs the process-work. Sometimes, several of the affected users are involved in the process-work to state their opinion.

4.2.3 Reviews of Processes

PDU/PAY has a standard review process that should be used at all reviews that are conducted. However, there are no formal requirement that processes shall be reviewed when they are developed or changed. Nevertheless, processes are often reviewed anyway, but it is up to the owner of the process to organise such reviews if he considers it as necessary. When a review is conducted, persons related to the process are often involved. This could be process users, people with knowledge in the particular area, and so forth. The selection is up to the owner of the process, and no requirements on the number of people exist.

4.2.4 Introducing Processes

There are no direct guidelines of how to introduce processes at PDU/PAY. Sometimes they are introduced as pilot projects and sometimes as organisational-wide launches. A change with large impact often needs a pilot project, such change is commonly developed with the aim that it shall be introduced in a specific project. Hence, the process can be evaluated before other projects start using it. An example of a large change could be to change the design-process from waterfall to iterative development.

Smaller changes, or changes that do not affect the lifecycle are often introduced as organisational-wide changes. An example of such could be changes in the inspection process, which are coupled to certain documents and hence do not affect other parts of the lifecycle.

4.2.5 Change Management of Processes

Today, there are no effective change management procedures of processes at PDU/PAY. Hence, there is no formal way to adjust the process and trace the adjustments. Change management of today is therefore equal to process improvement (4.3).

4.2.6 Training of Processes

There is no formal training procedure present on how to use developed or improved processes. In most cases, the descriptions are published at the process web or in any other forum and the users of the process are supposed to look for the information themselves. However, some training are often made in the projects and in those cases, it is up to the project manager to provide the users with adequate training. This training could be everything between telling people to read some processes, to have a presentation or equivalent to teach them about it. The amount and technique of training is of course also much dependant on which people (experience etc.) that are involved in the project, and which processes that are to be used.

4.3 Process Improvements

4.3.1 Suggestions of Process Improvements

When processes shall be developed or improved they must have an origin. Suggestions could be received by the owner of the process from several sources such as users and upper management. It could also be posted by another process owner that encounters that the criteria between processes do not match. The forum where suggestions can reach the owners of the process is by their names, which are present on each description on the process web. This way, people knows whom to contact and can send them an e-mail with the suggestion that they have. It is also possible to contact the administrators of the process web if the suggestor does not know whom to contact, or if it affects several processes. The suggestions could be posted when users do not understand the process, if they cannot work according to it, or likely.

When suggestions for new processes or improvements of existing processes are received by the company, short-term suggestions are most often more appreciated than long-term suggestions. This is because that with short-term suggestions, it is easier to see the direct result of the improvement. A long-term suggestion is harder to measure and is potentially affected by other factors that are not controlled.

4.3.2 Evaluations of Process Improvements

Two ways of evaluation could be used when a process already is developed and evaluations of processes shall be conducted. First, in the conclusion phase in PROPS (Ericsson's project management model), conclusions and evaluations of the project shall be conducted. However, these conclusions are often made by the project manager with little or no participation from other involved persons in the project. Further, these conclusions are rarely communicated to persons that are responsible for processes and therefore, processes do not take advantage of the lessons learned.

Sometimes, another evaluation of projects is conducted as well. This evaluation involves all participants in the conducted project in order to evaluate what the project did well and what it did not so well. This, as well as the PROPS-related evaluation, is not only process related but does also cover other aspects. However, it tries to inform all stakeholders (including owners of processes) of what was good and what was bad. Unfortunately, this evaluation is not always conducted; and if conducted, not always very effectively.

When doing both of these evaluations, no specific technique is used. Root Cause Analysis (Jones 1994) is used in some evaluations, but this technique is just used when things have gone extremely wrong.

4.3.3 Measurements of Improvements

Today, measurements of improvements are very seldom performed at PDU/PAY. The main reason for this is that PDU/PAY consider the projects too diverse to be able to do accurate measurements on. With diverse projects, measurements are affected by factors such as customers, involved employees, training provided, management, and so forth. Due to this, the measurements that are conducted, are done through questionnaires or equivalent, and these mostly focuses on subjective matters. This is done whenever it is possible and they do not consider the learning-curves of new processes (3.2.8).

4.3.4 Objectives and Goals of Improvements

PDU/PAY's primary objective when doing process improvements is to make the work more effective and the products more competitive (e.g. productivity, quality, and cycle-time) and not to achieve some certification (e.g. ISO9001 2001) or compliance to a specific model (e.g. Paulk *et al.* 1995 (CMM)).

When goals are stated for specific process-related work, the goals are primarily set by the owner of the process. Additionally, managers at a higher level also has the possibility to define the goals with the work. For example, a newly stated goal was set by the management, which stated that the design process should be faster. This was then handed to the owner of the process in order to work out a solution to meet this goal.

4.3.5 Tools to Support the Process or vice versa

The course of action that PDU/PAY applies when improving the process in relation to tools, differ among the different owners of the processes. Some of them are trying to introduce a tool and then shape the process according to it, without considering the "old" process. Others, preferably try to introduce a good process that people adhere to and then try to find a tool that support the way of work. The former of these two approaches are today the most common strategy.

4.3.6 How Process Improvements are Performed

According to the process web, process improvement should start with a service request (a demand for maintaining or improving a process) from a stakeholder within the organisation. When this is received by the owner of the process, it should be analysed and assessed. If the request is accepted, it should be incorporated and maintained according to the Plan-Do-Check-Act cycle (Deming 1988).

A service request considers small improvements and error corrections of processes. If it is large and extensive and not possible to just incorporate it into the Plan-Do-Check-Act cycle, a change request should be made. Such a change request should get analysed and assessed and if considered as relevant, a larger project should be planned with the aim to investigate and develop the process. The above described way does not often happen in reality although it is described at the process web. The current way of improving processes is often when some process owner feels that his process needs to be improved, he starts a project.

While the information at the process web tells people what they should do in process improvement, there are no such detailed guidelines for how to perform the improvements and which people that shall be involved. Many respondents during the interviews complained about that the process work was done over their head and without influence from the people that works within the process (7.1). This was confirmed by people with good insight in the improvement process. Therefore, it seems that process improvements of today at PDU/PAY often is a true top-down approach with only managers, quality coordinators, and so forth, developing the processes.

One problem with process improvements today at PDU/PAY is that improvement efforts are not coordinated and communicated between departments and people. Today, the same work could be performed at several departments at the same time. This way does not just make it more expensive but it creates conflicts as well within PDU/PAY.

4.4 Summary of Chapter

The process related work today at PDU/PAY is distributed across the organisation. The owners of processes are responsible for the work and have often a work group as help for performing the improvements. The people involved have no formal training in conducting such work but they are themselves responsible for getting the information that is needed. However, there is a rather new tool for these people to conduct their work, and it is called the "process web". These internal web pages contain information regarding what should be present in a description, information on where and how they should distribute the result and so forth.

While the process web is a very good tool for its purpose, some information is still missing for people on how they shall perform the process-related work. Hence, the descriptions and the work methods of getting the descriptions of processes are differing. The amount of training, evaluations, measurements and so forth are also differs, depending on which person that is responsible for the particular process.

Chapter 5

The Requirements Process at PDU/PAY

***“Things are not always what they
seem”***

Aesop (620-560 B.C)

This chapter describes the present way that PDU/PAY deals with requirements and is based on the interviews that were conducted within the RM-project (1.5.2), and the documentation about requirements handling that is available at PDU/PAY. First, the flow of the requirements is presented as it is generally working today and then the five most mentioned areas for improvement found during the interviews are discussed.

Note that this chapter does not attempt to explain issues in requirements engineering, or state-of-the-art techniques. The purpose is to give the reader knowledge about the requirements process at PDU/PAY, as a foundation to discussions that are made in the improvement proposal chapter (chapter 8). In that chapter, the requirements process (as described in this chapter) is used as a case for how process management could be performed in the future.

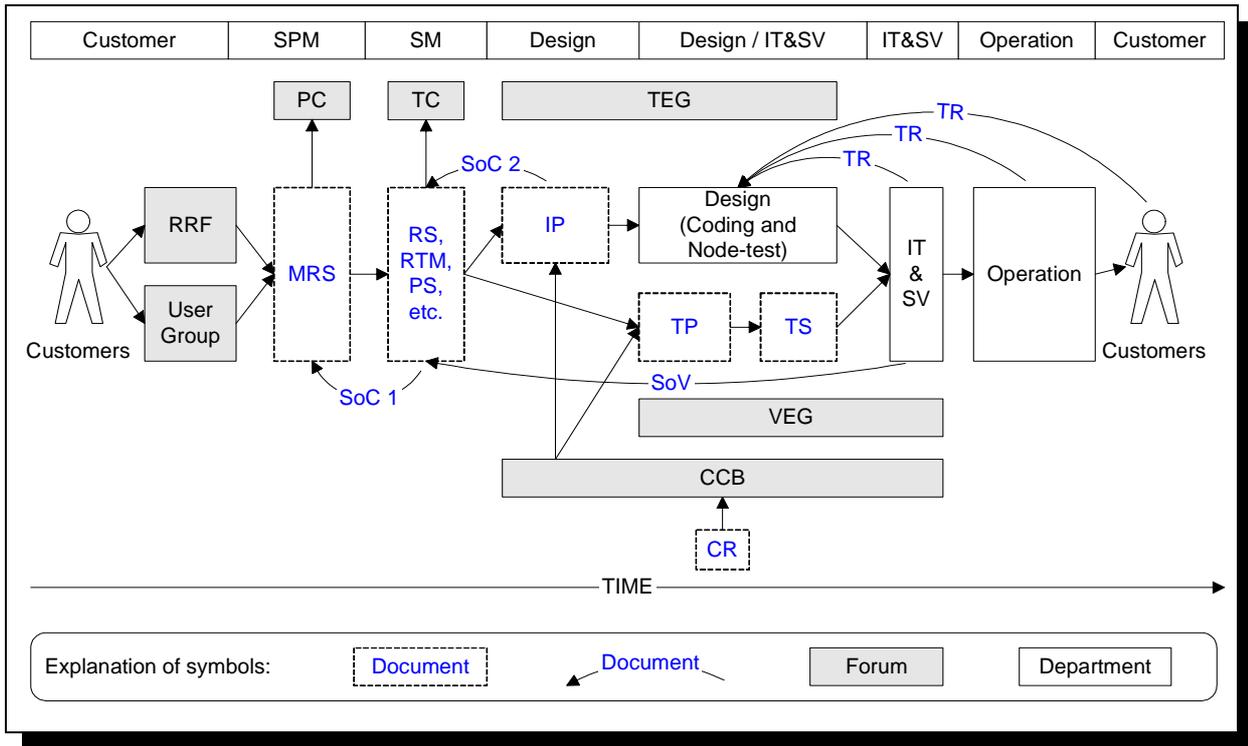
5.1 Current State of the Requirements Process at PDU/PAY

Today, the requirements process at PDU/PAY often differs between projects regarding work structure. Nevertheless, some patterns can be recognized and it is possible to see that most flows are commonly agreed within the organisation. Therefore, it is possible to give an overview of the process at PDU/PAY and it is illustrated in Figure 5-1. This figure introduces the requirements flow during a project and an explanation of the figure is presented in 5.2. To get a better understanding and a clearer view of the requirements process, 5.3 explains how the process typically is performed.

The flow explained in the figure was more or less consolidated among the respondents during the interviews in the RM-project. When it comes to parts where the requirements process differs between the projects, the figure is based on the best practises used today and the documentation available. Today, the general problem at PDU/PAY is not which steps, forums or documents that shall be included in the

process, but how and when they shall be conducted, and which involved parties that shall be represented. The most mentioned specific areas for improvement during the interviews are presented in 5.4, and the purpose is to give a view of these areas, and why the process is not working optimally.

Figure 5-1: The current requirements process at PDU/PAY.



5.2 Departments, Forums and Documents

5.2.1 Departments

Customers: The customer is an organisation that wants to buy a product from PDU/PAY.

Strategic Product Management (SPM): The Strategic Product Management department handles the contact with the customer, elicits and put requirements into the Main Requirements Specification (MRS) of the product.

System Management (SM): The System Management department breaks down the Main Requirements Specification produced by Strategic Product Management into the different Requirements Specifications (RS), the Requirements Traceability Matrix (RTM) and the Protocol Specification (PS).

Design: The Design department designs and implements the product. They also have a test unit (Node-test) that performs the functional test of the system before handing it over to integration test and system verification.

IT & SV: The Test department verifies that the implementation satisfies the conditions stated by the requirements. The two test stages are Integration Test (IT) and System Verification (SV).

Operation: The Operation department handles the product after the testing is completed and prepares the product for market entry. The department also has the responsibility for support and other services to the customer.

5.2.2 Forums

Requirements Request Forum (RRF): This forum is used to retrieve requirements from customers so that Strategic Product Management is able to have a common forum where all requirements are collected. The forum is web based and all stakeholders have the ability to post a request for further analysis by the Strategic Product Management.

User Group: This forum is used by Strategic Product Management to discuss and clarify requirements with the customers.

Product Committee (PC): This is a product forum where the Main Requirements Specification is inspected and approved. The forum typically consists of Strategic Product Management, System Management, Customers etc.

Technical Committee (TC): This is a product forum where the Requirements Specification is inspected and approved. The forum typically consists of System Management, the technical coordinator of the project, Strategic Product Management etc.

Technical Expert Group (TEG): This is a project forum used within the project to clarify requirements and coordinate the development of requirements between design units. The forum typically consists of technical coordinators from the different units and the main technical coordinator.

Verification Expert Group (VEG): This is a project forum responsible for the technical coordination of all verification activities in a specific project. This means that they assist project management with planning and follow-up of verification activities. The forum typically consists of test coordinators from different test units.

Configuration Control Board (CCB): This is a project forum, which approves and maintains the requirements baseline within the project. The purpose is to evaluate and approve, or disapprove, proposed changes and to ensure implementation of approved changes. The forum typically consists of stakeholders that are affected by the potential change.

5.2.3 Documents

Main Requirements Specification (MRS): The Main Requirements Specification is used to specify the customer needs for the release at system level.

Requirements Specification (RS): The Requirements Specification breaks down the requirements from the Main Requirements Specification into more technical requirements that enables design.

Requirements Traceability Matrix (RTM): The Requirements Traceability Matrix is derived from the Requirements Specification and traces to which design unit each requirement is distributed.

Protocol Specification (PS): The Protocol Specification is developed by System Management and describes all parameters that are supported by a certain interface.

Statement of Compliance (SoC 1): This document is developed by Strategic Product Management and is used to get an agreement between Strategic Product Management and System Management upon what main requirements that have been inserted into the requirements specification.

Statement of Compliance (SoC 2): This document is developed by System Management and is used to be the agreement between System Management and Design upon what requirements that have been implemented by Design.

Implementation Proposal (IP): The purpose of this document is to anchor the technical solution of the requirements from a design and system perspective.

Test Plan (TP): The purpose of this document is to be used as input for planning of test activities and for preparation of the test environment.

Test Specification (TS): The purpose of this document is to specify the test procedures required for verification of the functionality and to verify that new functionality is implemented as stated in the Requirements Specification.

Statement of Verification (SoV): This document is developed by System Management as a part of the Statement of Compliance (SoC 2) and is used as an agreement that the implemented requirements are verified.

Change Request (CR): This document is written by a stakeholder that has encountered that a change in the requirements specification must be made.

Trouble Report (TR): This document is written by a stakeholder that after using the product found a fault within it.

5.3 A Typical Requirements Process Scenario

The requirements process starts with one or more customers posting a demand in the Requirements Request Forum. In this forum, the Strategic Product Management is able to retrieve all demands that are posted from different stakeholders. Then the demands are analysed and the Strategic Product Management brings up the most interesting demands to a user group where different stakeholders are represented. In this forum, all demands are discussed and the outcome is an agreed list of requirements by the stakeholders.

Strategic Product Management takes this list and develops the demands into requirements to be inserted into the Main Requirements Specification. When this is ready, it is reviewed and approved by the Product Committee. Thereafter the Main Requirements Specification is handed over to System Management who decomposes the requirements into more technical requirements. These are then written in the Requirements Specifications, the Protocol Specification and the Requirements

Traceability Matrix. Further, the documents are reviewed and approved by the Technical Committee. When the Technical Committee has approved these documents, a Statement of Compliance (SoC 1) shall be written to assure Strategic Product Management that the original requirements are fulfilled in the produced documents.

Thereafter, the documents are handed over to design and test. Design takes these documents and develops an Implementation Proposal. When this is ready, they make a Statement of Compliance (SoC 2) to System Management to ensure that all requirements are possible to implement. If there are any uncertainties about how to interpret the requirements, the designers contact the Technical Expert Group in order to clarify and partition the requirements among the design teams.

When the Implementation Proposal is complied with System Management, the designers start to implement the product. At the same time, the testers are starting to produce the Test Plan and the Test Specification. When Design has implemented the requirements, they are tested by the Node-test team that is connected to each design team. When this first test-phase is completed, the product is handed over to the Integration and System testers. If these testers have problems with partitioning the tests between each other, they consult the Verification Expert Group that partitions the tests between the units.

Between the time when System Management leaves their documents until the product is approved by the testers, any stakeholder can make a Change Request. The Change Request is analysed by the Configuration Control Board and if the request is regarded as relevant, it is considered as a change of the original requirement. When the testers have tested the product so that it satisfies the needs, they shall make a Statement of Verification to System Management to ensure that all requirements are tested. When this is done, they can hand over the product to the Operation department who prepare the product for customer use.

During the whole verification phase, the involved parties are obliged to write a Trouble Report if they encounter a problem with the product. The Trouble Report is communicated to the affected design team in order to give them the possibility to correct the fault.

5.4 The Five Most Mentioned Areas for Improvement

Although the requirements process seems to be in order and working fine according to Figure 5-1, there are some areas to improve that were found during the interviews in the RM-project (1.5.2). The five most mentioned improvement areas are the following:

5.4.1 Traceability

Today, the traceability at PDU/PAY is an area to improve. The problems start when System Management hands over the requirements to Design, then requirements are starting to live their own life and the organisation loses some control of the requirements. This is due to that System Management and Strategic Product Management leave the project at this stage and do not follow-up the requirements.

The traceability present at PDU/PAY is created through the Requirements Traceability Matrix, Statement of Compliances, and Statement of Verification. Further, the Statement of Compliance (SoC 1) and Statement of Verification are rarely used and the Requirements Traceability Matrix is not always used. Today, it is hard to see which requirements that are dependent on each other. It is also hard to see where a requirement is implemented in the system, and to trace a trouble report all the way from test cases and code to the original requirement.

While traceability within a project is an area for improvement, the traceability between projects is in larger need for improvement. It is more or less impossible to trace requirements back to past releases of the same product. The main reason for this is that Requirement Specifications are considered as project- instead of product documents; hence, they are not following the product's lifecycle.

5.4.2 Involvement in Elicitation and Definition

Another area for improvement that several respondents have argued about is that they are included in the requirements process too late. This makes the validation suffer because Design, Test, and Operation do not get the chance to influence and understand the requirements as they would wanted to. When and if they are participating in the process it is often to inspect the specification, and in this stage it is often too late for major adjustments, due to time constraints. All these departments want to be a part of the development of the Requirements Specification so that all requirements are clear when starting the feasibility phase. Another area for improvement is that the customer is not as involved in the requirements process as they could and the departments have trouble to validate the requirements against the customer needs.

5.4.3 Change Management

The change management today at PDU/PAY in the requirements process could be better. When a change request is posted, the analysis of the change request sometimes is poor and it does not always involve all affected departments. For example, the Operation department is seldom a part of a Configuration Control Board and the impact on this department is therefore not always analysed in a Configuration Control Board.

When a Change Request is accepted, involved documents are not always updated and this is something to improve. For example, when a person wants to read the requirements specification he must look in several documents to see if the requirement is changed since the Requirements Specification was written, this is a time consuming activity. This is not limited to the Requirements Specification; it seems to be a general problem with several documents. Thus, it is hard to know if a document is still valid or has been changed.

5.4.4 Undefined Interfaces

One of the most urgent improvements to make today is that persons at PDU/PAY do not have a common knowledge about the interfaces between departments and phases of development. This causes problems in the development. It is important for the personnel that they are able to see the whole development process, what their role in the chain is, and which other stakeholders they have to interact with. Today, the people often do not know who to interact with, and what they need to speak about. Today, this is often handled through the experience and social networks of individual people. Due to this, people do not know which stakeholders that need the

information that they produce and the people that do not receive the information must "hunt down" the information themselves, which is a time consuming activity.

The problem with ill-defined interfaces reflects on Figure 5-1, the illustration could almost be purely vertical because the phases does not always follow each other in reality; they work in parallel. For example, the Design department might design the system before the Requirements Specification is approved. Therefore, they could design requirements in the wrong way, or design requirements that should not be a part of the final solution. If the interfaces would have been more clearly defined, this would not have been a problem because then actors would have known what input the consecutive actor must have to be able to work.

5.4.5 Documentation of Requirements

The structure and documentation of the Requirements Specification are another area to improve at PDU/PAY. The specification is sometimes poorly written, which makes it hard for concerned parties to read and interpret the document. This interpretation is time consuming and the only way to be certain that it is interpreted right is to ask the author, which takes time from both parties. The ability to overview the document is also a concern; some documents are written in hundreds of pages divided into several documents. Thus, it is hard to find the right information. Several respondents asked for the possibility to group the requirements according to specific needs which would enable a better overview.

Another area of improvement is that non-functional requirements are not always documented and this causes the test department some trouble; the test department does not know which non-functional requirements they need to test and must do their own estimates on these tests. The respondents also have encountered problems with that the authors of the Requirements Specifications does not have any education; hence, Requirements Specifications differ (e. g. level, focus) between different authors. This makes it hard for readers of the specification to get a continuum in their work.

The prioritisation of the requirements is something that could be improved as well. Today a must-, should- and may-system is used but this is not working well because of that almost all requirements are prioritised as must-requirements and there is no room for prioritising in-between these. Respondents argue, that a good prioritisation must be carried out with the customer so that it is possible to concentrate on the most important requirements first.

5.5 Summary of Chapter

This chapter discusses the requirements process at PDU/PAY which today works in a rather structured way. There is a main flow that people agree about but when it comes to the detailed level there are diversities regarding how staff interpret the process. Because staff do not really know how and where to find process descriptions, the process becomes very dependent on individual persons with great experience and knowledge. The largest problem is that staff often know about different departments, documents and forums but they do not know the purpose and the content of them, neither which persons that shall be involved and informed about the results.

Chapter

6

Method and Design

“The good researcher is not ‘one who knows the right answers’ but ‘one who is struggling to find out what the right questions might be’”

Phillips and Pugh (1994, cited by Dawson 2000)

The purpose of this chapter is to provide the reader with the basic knowledge about research and research methods. Additionally, the chapter aims to describe the design of the study conducted in this master thesis and what considerations that were made in order to obtain reliable results.

6.1 Method

This section aims to provide the reader with the basic knowledge about what research is and what considerations that should be done in order to obtain reliable results. Research methods, how to collect the data, and how to validate the data are discussed.

6.1.1 Empirical Research Methods

Empirical Research Methods could be divided into three categories (Robson 1993, cited by Johansson 2000):

Experiment: An experiment is made in order to investigate relationships between factors and test these according to each other (Dawson 2000). This means that a particular event is replicated with some conditional difference to control its outcome. Hence, it could be evaluated if the conditional difference affected the event positively or negatively. Experiments are often conducted in small scale with great control (Kitchenham *et al.* 1995)

Case Study: A study focusing on a single project that is not replicated is called a case study; in other words, an investigation that is conducted on a particular situation or problem. This can be made directly (e.g. interviews, observation) or indirectly (e.g. studying company reports, documentation) (Dawson 2000). Case studies are conducted in typical conditions (Kitchenham *et al.* 1995).

Survey: Surveys look at many teams and projects at the same time, and are usually undertaken by interviews or questionnaires. Hence, it includes larger amount of data than case studies. Therefore, more consideration must be taken to identify samples, select samples, design questionnaires and define interviews (Dawson 2000; Kitchenham *et al.* 1995). Surveys are research in large scale (Kitchenham *et al.* 1995).

6.1.2 Approaches for Collecting the Data

When collecting the data in either of the research methods explained in 6.1.1, some approach must be taken of how to collect the data. The question is whether to do a qualitative or quantitative investigation. Below, explanations of the two are presented and then how to choose between them.

6.1.2.1 Qualitative Approach

Simplified, we could say that a qualitative study distinguishes by asking simple straightforward questions while getting complex answers that contain a lot of information. Therefore, when having conducted the investigation, the investigator has a lot of material to analyse and try to find patterns, happenings and views within (Trost 1997). When analysing the answers, the investigator must interpret the answers and try to understand what the respondents really meant (Trost 2001), issues like frame of reference, motive, social processes, and social context affect the results (Holme and Solvang 1997). The data collected in a qualitative study could be captured in several ways, such as by observation, interviews, and ethnographical studies (Martella *et al.* 1999)

6.1.2.2 Quantitative Approach

Simplified, we could say that a quantitative study distinguishes by introducing numbers into the answers. It must not be just numbers in the general definition but also in a figurative sense where words as longer, more, and larger could be used (Trost 2001). The advantage of quantitative studies is that statistical analyses could be used to express the relationship of factors (Holme and Solvang 1997). Therefore, it is important to know the rules for what we can do with the information that is collected in a quantitative study.

Quantitative studies are not able to find unknown information (Silverman 2001) and must therefore be supported by qualitative studies in order to find information that is not known. When the information is found, it is possible to investigate its magnitude through quantitative studies. It is also possible to generalise the results to a larger extent in quantitative studies (Holme and Solvang 1997). The data collected in a quantitative study are most often captured by questionnaires or interviews (Holme and Solvang 1997).

6.1.2.3 Choosing between the Qualitative and the Quantitative approach

When choosing which approach to use, there is no right or wrong answer but rather that the approach used depends upon what purposes the investigation has (Trost 2001). Further, the two different techniques are not mutually exclusive; it is possible to do a pre-study by qualitative studies and the main investigation by quantitative studies, or vice versa. In fact, combining them are often to prefer (e.g. Martella *et al.* 1999, Trost 2001).

6.1.3 Validity of the Result

When doing either qualitative or quantitative studies, some factors must be taken into consideration regarding how trustworthy the result is going to be.

6.1.3.1 Sampling of Respondents

It is important to have the right people to respond to the investigation, a common rule is to have as many as possible to be respondents to achieve as accurate results as possible. Nevertheless, it is often impossible to have all people in a population as respondents (Trost 2001), and sampling of respondents must therefore be made. It is important that this sample corresponds with the whole population the researcher wants to describe (Martella *et al.* 1999). Factors to consider when sampling are: How accurate must the investigation be? How many answers are the investigators able to handle? How much effort is reasonable to demand from the respondents (e.g. could a company afford all employees taking time to answer?)? (Trost 2001).

The above discussion is primarily aimed at quantitative investigations; qualitative investigations might even be designed in the opposite way. In qualitative investigations, the strategy could be to get people that are not typical for the event to answer because it could illustrate the different viewpoints that are present in the population (Holme and Solvang 1997). Nevertheless, they must be a part of the population that shall be investigated in order to get viewpoints within that population.

6.1.3.2 Standardisation

Standardisation refers to the degree of which the questions and situations are the same for the respondents. With low degree of standardisation, the questions are adapted to the respondent regarding language, follow-up questions depending on answer, the respondent steering the order of the questions etc. With high degree of standardisation, the questions are read in the same order, they are formulated the same etc. (Trost 2001).

The level of standardisation differs between different investigations. When extensive answers as in qualitative studies are preferred, the level of standardisation might be relatively low. When more specified and quantifiable answers are preferred, a higher level of standardisation is to prefer to get as accurate answers as possible (Trost 2001). This implies that qualitative studies are characterized by flexibility while quantitative studies are characterized by standardisation or structure (Holme and Solvang 1997).

6.1.3.3 Validity and Reliability of the Results

Validation of the investigation is necessary in order to know that the investigation could be trusted. The validity of an investigation is the degree of which the analyst measures what he intends to measure (Martella *et al.* 1999; Kendall and Kendall 2002). For example, if the intention is to measure how many days a week a person reads the newspaper, the answer given in a questionnaire should be based on how many days he reads it and not if he reads it often or seldom which involves a great deal of subjectivism by the respondent (Trost 2001).

Reliability, on the other hand, refers to how consistent the investigation is over time (Martella *et al.* 1999) and if the same results are found if the investigation is done more than once. This aspect is often related to the standardisation and the design of the questions. For example, if the questions are straightforward, not contradictory and performed under the same circumstances, they are more likely to be interpreted the same way by the respondents and hence more consistent (Trost 2001).

6.1.3.4 Validation of Research

When reviewing the research that has been conducted, it is possible to use techniques to validate that the information retrieved are as accurate as possible. One way to do this is by triangulation. According to Patton (1990, cited by Martella *et al* 1999), four different types of triangulation exist:

Data Source Triangulation: The purpose of this triangulation technique is to validate the investigation by providing a secondary source of information (e.g. support an interview with observation). By this, it is possible to find biases between what people say and what they do.

Analyst Triangulation: This technique uses multiple analysts of the obtained data. If just one analyst is used, it is possible that the result is much dependent on his interpretation of the material. With more analysts involved, the risk for this bias is reduced. This could also be supported by several researchers involved in the study, and compare their conclusions.

Theory/Perspective Triangulation: This kind of triangulation is based on that validity can be obtained by interpreting data from different theoretical perspectives. It could for example be done by collecting data on a subject from a behavioural and a cognitive viewpoint.

Methods Triangulation: This technique involves comparing the data collected from several methodologies such as quantitative and qualitative methods. The difficulty is that two different methodologies are not always appropriate for the same research question. However, the idea is that if several researchers come to the same conclusion using different methods, they are more likely to be accurate.

6.2 Design of Research

The purpose of this section is to give the reader an overview of how the study was conducted and what considerations that were made when developing the study.

6.2.1 Choice of Research Method

Because information was shared between different departments, projects and persons at PDU/PAY, the survey research method was selected. This method was used in order to collect information from all affected parties at PDU/PAY so they could give their point of view of the process related activities of today and in the future.

6.2.2 Choice of Collection Approach

The approach in this master thesis was to first do a qualitative study in order to get an overall understanding of the situation today at PDU/PAY. This study was conducted within the frame of the RM-project (1.5.2). This qualitative session served as a base for both the literature study and the following quantitative study. With the result of the qualitative study at hand, it was easier to focus on what literature to look in for information. It was also easier to develop questions for the quantitative study, which more focused on the order of magnitude the results of the qualitative study had and as a validation of the qualitative study.

6.2.3 Sampling of Respondents

Because of the nature of qualitative and quantitative studies, the sampling differed between the two studies. The qualitative study did not involve as many respondents as the quantitative because of time constraints. Further, the qualitative study was more constrained because it was within the RM-project and the personnel at PDU/PAY determined which respondents to include.

6.2.4 Standardisation

The standardisation between the two studies differed a lot. In the qualitative study, the respondents had great freedom to steer the order of the questions and so forth. It was conducted like a discussion around certain predetermined topics present in the requirements process, which made the interviews rather flexible. On the contrary, the quantitative study was more structured with questions and answers predetermined in a questionnaire (Appendix A).

6.2.5 Validation of Data

In order to get as reliable result as possible, validation of the data was performed. Two triangulation techniques were used and they were: Analyst Triangulation and Methods Triangulation.

First, within the RM-project several analysts were present during the interviews which all had their personal interpretation of the answers. When the study was performed, the conclusions of the different analysts were discussed and consensus was reached. Further, when the chapters regarding the study were written (chapters 5 and 7), affected analysts reviewed the results in order to validate the interpretations in this master thesis.

Secondly, two different methods of collecting the data were used. The RM-project was based on qualitative data, which is rather hard to interpret. The quantitative study, which was derived from these interpretations, validated if they were accurate. Further, the quantitative study measured the order of magnitude the responses had in a larger population; additionally, this study was also more carefully selected to reflect the population of the organisation.

6.2.6 Qualitative Study (RM-project)

The RM-project was conducted together with personnel from PDU/PAY. The intention with the RM-study was to collect the state of today's requirements process at PDU/PAY. The group consisted of one to two participants from PDU/PAY (one was not available for all interviews) and one internal Ericsson consultant specialised in requirements processes. Additionally, this master thesis was represented as an external part, which mostly concentrated at matters that was general process-rather than requirements process related.

The questions developed and the sampling of the population was mainly conducted by the people from within PDU/PAY (and the internal Ericsson consultant). Hence, the questions were mostly focused on the requirements process, but many discussions related to general process topics. Therefore, much information could be retrieved about processes that were interesting for this master thesis (chapters 5 and 7). The problem with this study was that the sampling did not really cover the whole organisation. Further, the departments that were represented differed a lot in number of participants. Nevertheless, all operative departments were present during

the interviews and the participants from each department ranged from 1 to 11, with a total of 25 respondents. These departments or their sub-units were interviewed in groups, ranging from 1- 6 participants in each group.

Most of the respondents in the study were managers or team leaders at their department. This affected the study in some sense because the staff at some departments were not represented at all, and could not give their view of the problems. Further, some of the managing departments were not represented at all in the study; mostly because they are not active participants in the requirements process. To get their opinion about process matters, a quantitative study was designed, which is explained below.

6.2.7 Quantitative Study

The purpose of the quantitative study was, as earlier mentioned, to validate the results from the qualitative study as well as discover the order of magnitude of the answers. The questions for the quantitative study are presented in Appendix A.

6.2.7.1 Questionnaire

The questionnaire comprised of 23 questions, plus demographics and one open ended question. The first 18 questions were multiple-choice questions where one alternative was to be chosen on each except from two questions (13 and 14) where the respondents were allowed to choose as many alternatives as they wanted. Questions 19 to 23 were weighted question where the respondents had the possibility to rank their answers. In addition to ordinary ranking, they had the possibility to put weights on their answers. This made it possible to see how much more important some factors were than others.

6.2.7.2 Sample

The aim with the questionnaire was to include 15 percent of the total personnel at PDU/PAY. Because some loss of respondents was suspected, the chosen sample was 20 percent of the organisation. To achieve the appropriate influence from all horizontal (departments/units) and vertical levels (management levels) of the organisation, each department was represented by 20 percent of their work force. Further, each department was represented by one line-manager. However, most departments could not be divided to exactly correspond to 20 percent. Hence, the sample became slightly larger than the originally planned (22%). This sample lead to that 84 (of 376) persons were chosen as respondents to the questionnaire.

6.2.7.3 Pilot Study

Before the questionnaire was sent out to the respondents, a pilot study was performed. This study was performed with three persons at PDU/PAY. The intention with this study was to evaluate if the pilot-study respondents interpreted the questions and answers as intended. The result of this pilot study was that some questions were not clear how to interpret, and these were rewritten. Further, the questionnaire was rearranged in some sense in order to get as reliable answers as possible.

In addition, the number of answers to the weighted questions were reduced. This was done due to that the respondents of the pilot-study encountered problems with answering because of too many answers. Therefore, a selection of which answers that would give this master thesis most valuable input was made, and others were removed from the questionnaire.

6.2.7.4 Collection of Answers

In order to get as many respondents as possible to answer the questionnaire, an e-mail was written to all managers at PDU/PAY. This e-mail contained a list with how many persons each department should provide as respondents. Hence, each manager could choose the respondents from his department and notify them about the questionnaire in advance. The e-mail clearly pointed out that they should select respondents with as accurate demographics (age, role, gender) as possible in order to get satisfying results from each department. This e-mail had a good response-rate, which resulted in the selection of 50 of the respondents. The remaining 34 respondents were chosen randomly from the departments and 10 of these were managers (which all were chosen randomly).

The approach with letting the managers choose their respondents could have biased the results. The manager might choose respondents he thought should give the most appropriate answers for him. However, when analysing the answers from respondents chosen by managers, and the answers from respondents chosen randomly, it showed that the answers did not diverge. However, a clear trend was that those chosen by their managers and notified in advance, was more willing to answer the questionnaire. The actual survey was also distributed per e-mail because no other solution was seen as appropriate.

6.3 Summary of Chapter

This chapter introduced research and research methods. Discussions about available methods, techniques for collecting data, and how to validate the collected data were made. Based on these discussions, an explanation of the design of the study conducted in this project, was made. The research in this project was conducted as a case study. There were two main steps in this approach. First, a qualitative study was performed in order to get a foundation for further research. Secondly, a quantitative study was performed in order to validate the results from the qualitative study and to analyse the order of magnitude of the results.

The qualitative study was performed within the RM-project and included 25 respondents, which was interviewed in groups and separately. The sample of the quantitative study was 84 respondents. This sample was with a loss-margin of 15 percent chosen in order to reach a total of 15 percent response from the organisation. The result from these studies is presented in the following chapter.

Chapter

7

Presentation and Analysis of the Survey at PDU/PAY

*"If you don't know where you are,
a map won't help"*

Watts S. Humphrey

This chapter introduces the result of the two studies that were made in this master thesis. First, the results of the qualitative and quantitative studies are presented. Second, the two studies are analysed and coupled together with each other and with the theory presented in chapters 2 and 3. Finally, the result is analysed in order to see how the findings relate to the problems encountered in the requirements process (chapter 5).

7.1 Presentation of the Qualitative Study

While observing the interviews that were made in the RM-project (1.5.2), several interesting opinions about the processes were noticed. Because of the nature of qualitative studies, some interpretation had to be done in order to understand what the respondents really meant. However, there are some areas that frequently came up, as well as there were areas that were really interesting but were just mentioned one or a couple of times.

7.1.1 General about the Result

Almost all of the respondents expressed that they are in need of usable process descriptions that they could use in their work. If they want to call it process descriptions, work descriptions, methods etc. differs, but the core is that they want a more structured way of working (further on, it will be called processes).

The main reason for people wanting process descriptions is that they want to minimise the dependency of key persons. Today, if the wrong person leaves the project, problems could be encountered because all his competence and contacts get lost. All of the respondent groups argued about this problem and the obvious solution is to introduce processes as a vehicle for knowledge sharing.

7.1.2 Specific Issues that were Found in the RM-project (1.5.2)

In the RM-project (1.5.2), some issues of the process handling were more frequently mentioned than others, and below follows a list of common mentioned areas for improvements (no internal ranking of frequency, severity etc.):

7.1.2.1 Change Management

Several respondents argued that process descriptions must live. Today, descriptions often are made and then forgotten about and not updated. To eliminate this problem, the respondents suggested that administrators that own and administrate each process should be appointed (according to 4.2.1, such owners should already be present). With such an approach, it could be possible to have revision handling of processes and be able to get back to the old state of the process if something is not working satisfactory.

7.1.2.2 Interfaces Between Departments/Phases

Interfaces seem to be important to define in today's processes, both in terms of communication paths and in terms of criterion for different documents. First, clear definitions are asked for in order for people to know whom to contact when something shall be performed or if they have questions. Secondly, the respondents ask for clearly defined criteria of how, what and when things should be handed over to the next development phase or department.

7.1.2.3 Measurements

People want to do measurements in order to see how they perform according to other projects (e.g. past projects). The respondents argued that it is hard (if not impossible) today to do such measurements due to the diverse ways of working between projects. Thus, knowledge sharing between projects suffer, if similar work procedures would have been used, measurements could determine the best way of working.

7.1.2.4 Synchronisation Between Processes

The respondents argue that synchronisation and integration between different processes is a must (e.g. synchronisation between design process and test process). The respondents seem to find it hard to see a continuum in the overall process because processes are not synchronised and integrated. This could for example mean that two consecutive phases have different entry and exit criteria of the same artefact (e.g. the first phase have x as exit criteria while the following phase has x and y as entry criteria), which result in the second phase having problems starting its work.

7.1.2.5 Baselineing/Anchoring

This is one of the most mentioned areas of improvement at PDU/PAY. Respondents argued about that processes were "forced" on them and they had no active part in the work of eliciting the requirements of the process. This often means that the process descriptions were not suited to their real working environment but rather was considered as an utopia; hence, they were often neglected. Further, several respondents argued that the most urgent measure is to describe and anchor current work procedures; not until it is done will any improvement initiatives have effect. One respondent expressed himself rather clear: *"The processes MUST be anchored in the real way of working"*.

7.1.2.6 Holistic View

A repeating subject during the interviews was the need for personnel to have a holistic view of the process. Several respondents felt that they did not see the whole picture of the requirements process; hence, they could not see what their contributions were. The impact was that motivation could suffer and they did not have a real commitment towards their work. Further, they felt that different departments did not work toward common goals but did just see to their own best. To get satisfying results in the company, shared goals have to be instituted, they argue.

7.1.2.7 Documentation

Some respondents argued that it is important that process descriptions have the right level of detail. If a process description is too detailed, it will imply that people stop thinking; which is not the idea, they argued. Further, they stated that the descriptions either are too detailed and too specific to reuse; or too fuzzy, so that they must be so much tailored for specific needs that they are not usable without much further work; this implies that they are not followed as intended. Further, the respondents argued that the processes must be short and easy to understand in order to get people to use them, and the number of descriptions must be fewer than today.

Today, descriptions are too extensive for people to take their time to read them and there are too many descriptions of each process. This makes it hard to know which one to use. The main reasons for why today's process descriptions are not followed are that they are hard to find, hard to understand and they do not fit the purpose, they argue. The essence of this part is what one of the respondents said, "*The process must be an aid in the work instead of a load*".

7.1.2.8 Adaptation

Another requirement the respondents had was that processes must be easy to adapt to certain occasions. This means that the processes must be dynamic to suit different circumstances. One respondent had opinions about Exception Requests (4.1.3), he thought that they are good but should not be followed blindly. Only in some situations should they be used (for example if an inspection should not be made), otherwise common sense should be enough for neglecting a part of a process.

7.1.2.9 Clearly Defined Roles

Several respondents argued during the interviews that they do not really know what role is doing what. The respondents think that the role definitions must be clearer and expectations on each role must be set. It is not enough to just say that a role should be present in a project without clearly having defined its responsibilities. Further, they argued that if the roles had been clearer, they would feel more responsibility and commitment towards their work, and hence be more motivated to do a good job.

With this qualitative result at hand, the quantitative study was performed to validate and determine the order of magnitude of the answers. The result of this quantitative study is presented in the following section.

7.2 Presentation of the Quantitative Study

The number of responses in the quantitative study agreed well with the expectation, 66 persons answered the questionnaire and they were proportionally distributed throughout the organisation. However, one person that had worked at PDU/PAY for just two months, were excluded because his answers did not agree with other's with similar demographics (department, role etc.). Hence, 65 answers were considered as reliable. This is equivalent to 77 percent of the sample, which corresponds to 22 percent of the organisation. The responses were also rather well distributed among roles, gender, age etc. (Figure A-24 to Figure A-27). However, as can be seen in Figure A-26, quality persons are just represented by two respondents. Hence, quality persons are not considered as a reliable sample and they are therefore in most cases excluded from further discussions.

The number of responses to each question varied. This is due to that not all people answered all questions, and some people did not answer some questions correctly. Below follows a presentation of the result of the questionnaire. The reference that is present last in each heading refers to the question's graph in appendix A.

7.2.1 1. How would you classify your own knowledge about current processes at PDU/PAY? (Figure A-1)

Generally, the respondents regarded themselves having "some" knowledge about processes at PDU/PAY. Nevertheless, the people have a slight tendency to answer that they have "little" knowledge, especially among the staff. Interestingly, all line managers answered that they had "much" knowledge about processes. Further, none answered that he has "very much" knowledge; while a few answered that they have "very little" knowledge. The general answer; "some", indicates that people knows about some processes but not all, or they know about the existence of processes but do not know very much about the content of the process descriptions.

7.2.2 2. What is your overall personal impression about the usefulness of today's process descriptions at PDU/PAY?(Figure A-2)

The overall impression about the processes at PDU/PAY is that they are "useful" (almost 50%). Nevertheless, relatively many (43.1%) answered that the processes are "neither" (useful nor not useful), or "not useful". Interestingly, sub-project managers all have the opinion that the existing processes are "useful".

7.2.3 3. According to your opinion, how detailed are the process descriptions today? (Figure A-3)

The opinion about how detailed today's process descriptions are is divided into two groups by the respondents. The most mentioned answers are that they have an "adequate level" (37.5%) or that it "depends on which description" (42.2%). The ones that mostly responded that it depends are line managers (66.7%) and staff (48.5%), while sub-project managers (60%) and team leaders (54.5%), are the ones that mostly argue they have an adequate level. When comparing the two "too"-cases, too general is a more frequent answer than too detailed.

7.2.4 4. To what degree do you use processes today? (Figure A-4)

According to the answers, processes seem to be relatively well used at PDU/PAY. Most respondents have answered that they use processes “often” or “sometimes”. However, a clear trend is that staff and team-leaders do not use processes very often. In these categories, “rarely” and “never” are more frequent than in other categories. In fact, if adding “rarely” and “never” in the staff category, these answers are as frequent mentioned as “sometimes” (29.4%); and if adding these two, they represent more than half of the answers (58.8%). This indicates that staff who uses processes “often” or “always” is fewer than those who uses them “sometimes”, “rarely”, or “never”. An additional comment that one respondent (answering “always”) added, was that this was valid when he could find the descriptions. Further, one respondent (answering “sometimes”) added; that if he should be honest, he did not know where to find process descriptions.

7.2.5 5. Who do you believe are the most active users of process descriptions of today? (Figure A-5)

The answers to this question are very interesting, all role categories believe that management and quality persons are the most active users of process descriptions. Only a small part (15.5%) of the respondents believes that staff is the most active users. Above all, “management” is the most mentioned answer (55.6%). An additional comment that one respondent (that did not answer the question) added, was that everyone is as bad at using the process descriptions.

7.2.6 6. Do you have influence in discussions regarding issues that affect your work (work descriptions, process improvement etc.)? (Figure A-6)

The responses to this question indicate that most people feel that they have influence in discussions regarding their work. Nevertheless, the trend is similar as in question 1 (7.2.1) and 4 (7.2.4); staff tends to answer that they have less influence than other categories. For example, 26.4 percent of the staff responded that they “rarely” or “never” have influence in these discussions. However, 47.1 percent of the staff answered that they “often” have influence in these discussions.

7.2.7 7. When you run into a process-related fault that affects other people, do you discuss it with them? (Figure A-7)

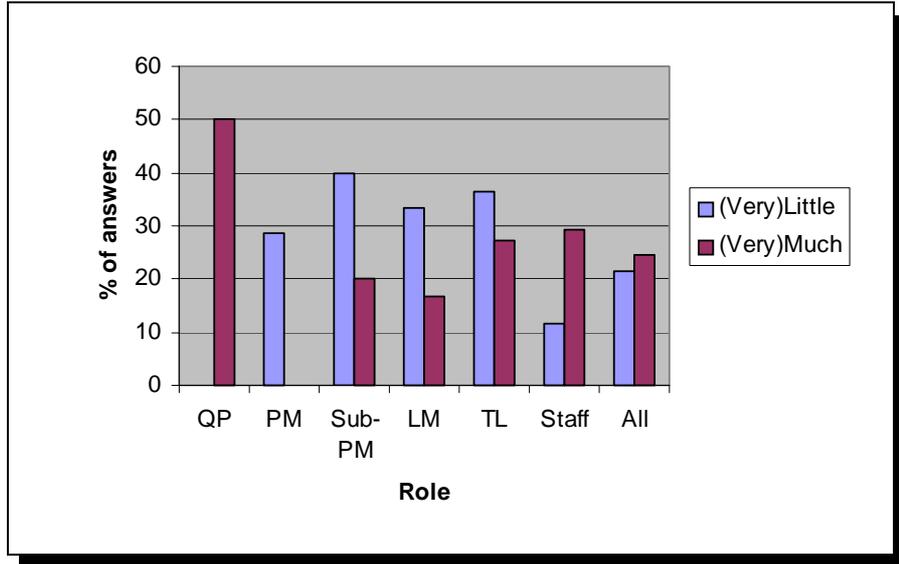
The responses to this question indicate that people “often” discuss their problems with other people. Nevertheless, the trend is similar as in question 6 (7.2.6) where staff answered that they do not discuss this issues with other people as frequently as other role categories. For example, “sometimes” dominates the answers from team leaders and staff, while “always” and “often” dominates the answers from the other categories. However, the overall picture is dominated by “often”, “sometimes” and “always”.

7.2.8 8. Does feedback from the receiver of your work results provide you with knowledge in order improve the results? (Figure A-8)

More than 50% of the respondents have answered that they “sometimes” depends on feedback in order to improve their results. Interestingly, staff and quality persons are the only categories where “much” and “very much” overweighs little and “very little” (Figure 7-1). Further, these two categories are the only two who have

answered “very much” to the question. In Figure 7-1, all respondents that answered sometimes are removed. The remaining respondents are divided in little (little and very little) and much (much and very much) groups depending on their answer

Figure 7-1: Question 8 revisited.



7.2.9 9. According to your opinion, is enough time devoted to develop structured solutions to problems? (Figure A-9)

The result of this question is that the respondents generally do not feel that they have enough time to develop structured solutions to problems (66.2%). Staff is the category that strongest feel that they do not have enough time (73.5%). The only category that states that enough time is devoted is team-leaders who slightly overweighs (54.5%) to yes.

7.2.10 10. How much time do you want to devote on process improvement activities? (Figure A-10)

The follow up question to the previous question indicates that people want to devote more time on process improvements. This is most evident within staff where 63.6 percent responded that they want to devote “more” or “much more” time. The overall result indicates that people want to devote “same” or “more”, and very few people wants to devote “less” or “none” time at improvement activities. The only category that overweighs “less” against “more” time is sub-project managers.

7.2.11 11. Are process descriptions updated as often as they should? (Figure A-11)

People generally feel that process descriptions are updated “too seldom” (63.1%). Staff, line management and project management are the categories that mostly feel they are updated too seldom while sub-project managers are the only category that overweighs towards that they are updated “too often” (40%). Further, it is interesting to note that the both quality persons answered that they think descriptions are updated as often as they should.

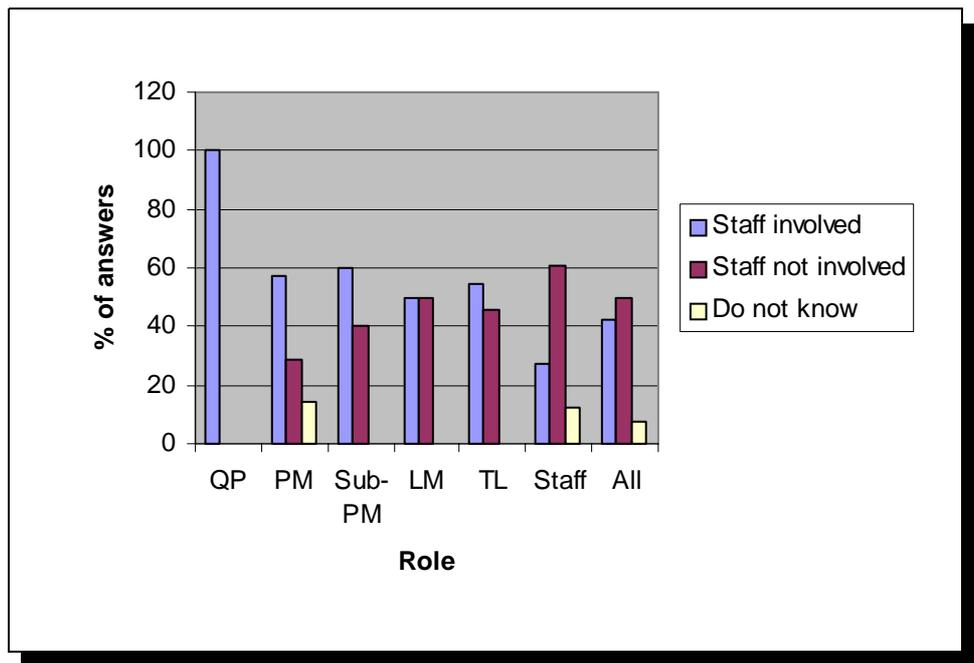
7.2.12 12. Do you change your way of working when processes are updated?(Figure A-12)

This question has a great potential of bias the result, because of the answering alternatives. Ideally, “occasionally” should be removed and replaced by “sometimes” which should be replaced by “often”. Because of the present structure, conclusions are hard to draw because we do not know if the respondents have interpreted “sometimes” as “sometimes” or “often”. However, one trend is possible to see even if we consider the possible bias. 35.2 percent of the staff answers that they change their way of work “occasionally” or “rarely”. This is a big difference according to the other categories where only few people have answered at these two choices.

7.2.13 13. Who develops processes and process descriptions today (more than one X is allowed)? (Figure A-13)

Because it was allowed to mark more than one answer on this question, a variety of combinations were received. This makes the original graph somewhat hard to interpret. Therefore, a modification that grouped the answers that had staff involved in one group, and staff not involved in another group was made (Figure 7-2). The modified graph shows that all groups except staff believes that staff are involved in the development of process descriptions. However, 60.6 percent of the staff say that they are not involved in this activity while 27.3 percent say they are. This indicates that it is mostly management and quality personnel developing descriptions.

Figure 7-2: Modified graph of Question 13.

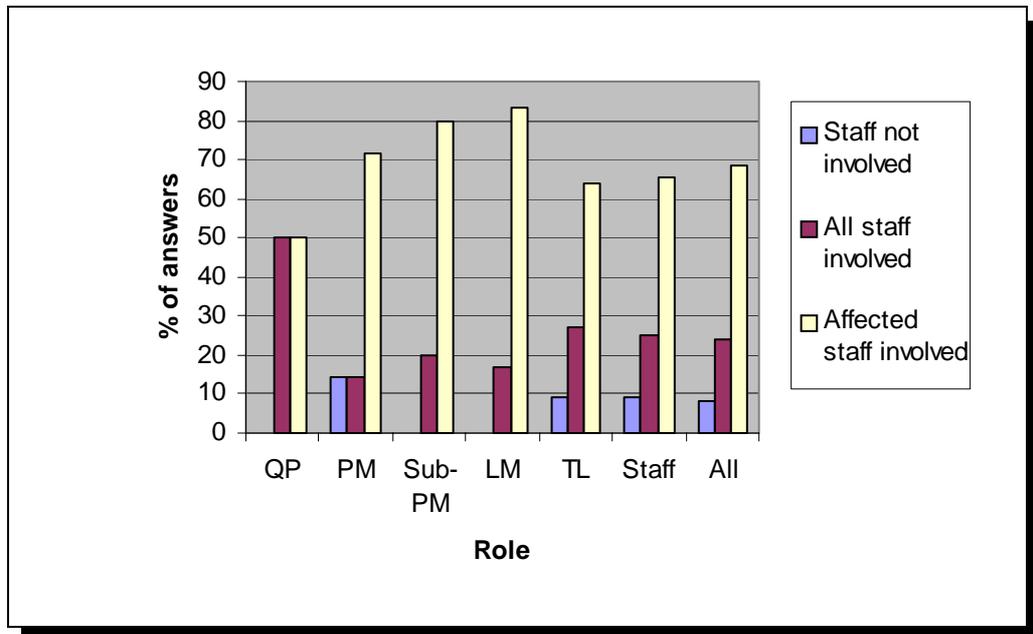


7.2.14 14. According to your opinion, who should develop processes and process descriptions (more than one X is allowed)? (Figure A-14)

This question is a follow up question to the previous one and was modified the same way to make it easier to interpret. Three groups are present in this modification; those who do not want to involve staff, those who want to involve all staff, and those who want to involve the affected staff (Figure 7-3). From this graph, one can see that almost all respondents (92.1%) wanted staff to be involved in development of processes, and affected staff are the single most mentioned group (68.3%). This is a common opinion through all role categories. The opinion whether to involve quality persons or management together with these people differ, but the bottom line is that staff should be involved. Only 7.9 percent of the respondents did not want staff to be involved.

One respondent that did not answer the question, further argued that the owner of the process should select work groups with affected parties of the process, to perform the work. This work should be performed as a line-organisation activity with concerned operative personnel. Another respondent, answering that just quality persons should develop processes, assumes in his answer that the quality person has the appropriate technical knowledge to perform the task.

Figure 7-3: Modified graph of Question 14.



7.2.15 15. According to your opinion, do different departments/units have an understanding for each other's work?(Figure A-15)

The general opinion at PDU/PAY is that the different departments and units do not have a understanding of each other's work (63.1%). Interestingly, staff is the role category that were most positive to this question while project managers and sub-project managers were the ones most negative to the question.

7.2.16 16. According to your opinion, how well are different processes synchronized with each other? (Figure A-16)

Generally, people at PDU/PAY responded that processes “could be better” synchronised with each other. They who are most positive to the synchronisation are staff and team leaders while sub-project managers and project managers answered that they were “bad” or “very bad” synchronized. However, if adding “could be better”, “bad”, and “very bad” to one category, it shows that 90.6 percent of the respondents thinks that the synchronisation of processes could be improved. One respondent who answered “very bad”, motivated his answer with: *“because changes occur without consideration of the stakeholders when changing process or line-organisation interfaces”*.

7.2.17 17. How similar do you consider the projects to be (regarding work structure, communication interfaces etc.)? (Figure A-17)

More than 50 percent responded that projects are “similar” regarding work structure, communication interfaces etc. However, due to the involvement in the RM-project and through discussions with people at PDU/PAY, it could be questioned if these answers are reliable. These discussions and observations gave a clear picture over the level of diversity between the projects, which does not correspond to the answers. The most probable cause is that the question does not specify the level of detail of similarities. For example, people might answer “similar” because design is followed by test in all projects. However, reflections in the RM-project showed that the role of for example TEG or CCB (chapter 5) was very different in the projects, and the attitude towards the requirements process was very different depending on which project the respondent was working in. Hence, because of the possible biases introduced by the question, no further conclusions will be based upon it.

7.2.18 18. Spontaneously, what is your immediate feeling when you hear the word “process”? (Figure A-18)

Most people at PDU/PAY are “positive” or “neutral” towards processes (38.5% each). Nevertheless, 23.1 percent regards processes as something “negative”. Team-leaders were the only role category that was overweighing negative to processes. Project managers, on the contrary, are the most positive towards processes.

7.2.19 19. When conducting process improvement, how is the relative importance divided between the following 5 factors?(Figure A-19)

The general opinion is that the affected users of the process should be involved, closely followed by management commitment. However, the mean answer is relatively even distributed between all factors (between 17.2 and 23.5). This could show either that none of the factors are important or that all factors are very important. When looking at question 14, 92.1 percent of the respondents stated that staff (users) should be involved in process management. This indicates that all factors are important due to the small differences between user involvement and others.

7.2.20 20. How is the relative threat against successful process management divided between the following 5 factors? (Figure A-20)

This question shows that many of the respondents think that synchronisation is the largest threat against successful process management. This factor is seen as the most threatening in all categories except for staff and quality persons. They see changes in work procedures that are not reflected in process descriptions as most

threatening instead. Wrong persons developing the descriptions, which was seen as very important in question 13 (7.2.13) and 14 (7.2.14), is just weighted as the fourth most threatening factor. This indicates that synchronisation, change management (in both directions) are very important threats finding solutions to. Interestingly, inconsistent process descriptions that were frequently mentioned in the qualitative study, are not seen as very important in this distribution. This is an indicator of the importance of synchronisation and change management.

7.2.21 21. How is the relative urgency divided between the following 7 problems that must be resolved? (Figure A-21)

Once again, synchronisation has a high mean value. Together with anchoring the current way of working, synchronisation is seen as the most urgent problem to resolve. Staff and project managers are those asking for anchoring the most, while anchoring is the lowest ranked factor by line management. Interfaces between departments and units is also seen as an urgent problem to solve. The possibility to tailor processes are also seen as something relatively urgent while change management, tools and a holistic view seems less important. This could be seen as strange with question 11 (7.2.11) in mind; but as in the two previous questions, all factors seem important.

7.2.22 22. How is the relative importance divided between the following 6 factors regarding content of a work description/process? (Figure A-22)

This question distinguishes itself from the past three because it is easy to see that workflows with entry and exit criteria are the one factor that people weigh as most important. Further, role definitions and “work instructions/guidelines/checklists” are rather equally weighted. However, due to the design of the answer of “work instructions/guidelines/checklists”, the answer could be misleading. The question is, which of the three the respondent meant in his answer; it could be all, or just one of them. Hence, no conclusions are derived by this answer. However, one respondent stated that focus should be put on checklists. This might indicate what others have meant, but conclusions cannot be drawn. Another interesting reflection is that project managers have answered that a communication scheme is very important (2nd ranked) while others have this as relatively low priority. Finally, templates, communication scheme and training material are not ranked as very important contents of a process.

7.2.23 23. How is the relative effectiveness divided between the following 5 ways to communicate/teach processes? (Figure A-23)

Workshops are the way of communicating/teaching that are most advocated by the respondents. These are followed by seminars and presentations. Role-plays and games do not seem to be very popular, especially among staff. This could be dependent on that people have not used it and have no experience with this kind of training. Many respondents have stated in their answer that they have answered based on their experience with the projects and processes that they have worked in. Further, one respondent (who answered zero on role plays and games) specifically stated that he had ranked the techniques used in his project. This leads to that the result of this question might be somewhat misleading, and not too much conclusions should be drawn from this question. However, presentations represents 24.4 of the answers. This means that people prefer alternative ways to presentation in at least 75 percent of the cases. This indicates that alternative ways are to prefer, if possible.

7.2.24 24-28. Demographic Questions

Questions 24-28 in the questionnaire were for demographic purposes. No presentation of this data is presented here; readers who are interested of this result are referred to Figure A-24 - Figure A-27.

7.2.25 29. Do you have any further viewpoints regarding this survey or the subjects and questions it has handled, please write them below: (A.3.2)

The respondents argued that PDU/PAY do not focus on the right things in process descriptions. In a process description, the important matter is the result that is produced, not how it should be produced. This implies that the important thing is to focus on entry and exit criteria that works across the line organisation. This synchronisation together with missioning the processes would increase the openness to processes. When missioning, it is important to not just focus on what the process provides, but also what differs it from the old process. Further, responses indicate that today's processes focus too much on producing documents that are large and extensive instead of producing process documents that are an aid in the work. The most important thing is to achieve goals rather than strictly follow processes.

When developing processes, the respondents argue that getting a grip of the current status is a key activity because this makes it easier to see potential improvements. This work should ultimately be run in project form in advance to their introduction. This also implies that all documentation and training should be provided before the process is introduced. When enforcing tools, local solutions tend to work best but global solutions are often better because it gives uniformity among the personnel. However, it is often forgotten that these global solutions, most often do not support the local processes.

The respondents also stated that process management is something that is neglected, which cost the organisation a lot of time and resources. When developing processes today, it is often the wrong persons who develops them. These developers do not have an understanding of how people work in reality. One respondent reflected that if management tries to shortcut the processes whenever something urgent happens, process management will not be any better. It is when it is urgent, the real need for processes occurs, he argues. Finally, one respondent argued that processes should be designed as software; do it simple, do not attempt to do too general solutions too early, understand what/how things work, and make it available.

7.3 Analysis of the Results

This section aims to analyse the relationships between the qualitative study (7.1) , the quantitative study (7.2), and the theory in chapters 2 and 3. Further, it discusses how the findings relate to the problems identified in the requirements process (5.4).

7.3.1 How does the Qualitative Result Relate to the Quantitative Result and the Theory?

In this section, the issues that were raised in the qualitative study are revisited. This time, it is compared with the result from the quantitative study and theories from literature. The reference that is present last in each heading refers to the section where the issue was mentioned in the qualitative study (7.1).

7.3.1.1 Change Management (7.1.2.1)

As stated in 2.4, change management is regarded as a key factor in process management. In both the qualitative and quantitative study (7.2.11), the respondents have argued that process descriptions are updated too seldom. This outcome might indicate that processes are something that are developed and then forgotten about. Further, the descriptions are not updated as the work methods improve and hence they are not reflecting the actual way of working. 7.2.20 also indicates that change management must be improved if process descriptions shall be used. A good change management process also facilitates the possibility to manage a process baseline as discussed in 3.2.3 and 3.2.9.

7.3.1.2 Interfaces between departments and units (7.1.2.2)

In the qualitative study, interfaces between departments and units were mentioned as an issue to improve. In the quantitative study, the answers to questions 15 (7.2.15) and 16 (7.2.21) confirm this. The problems; however, is rather similar to those in synchronisation of processes. Therefore, this problem is further discussed together with synchronisation between processes (7.1.2.4).

7.3.1.3 Measurements (7.1.2.3)

According to the discussions in 3.2.3, baselining processes is necessary in order to do accurate measurements of the processes. Due to that people does not use processes very frequently (7.2.4), they see a need for anchoring the current way of working (7.2.21) and due to the diversities in work methods that have been observed (7.2.17), measurements cannot be used very successfully until these problems are solved.

However, some measurements can be made, through techniques that are presented in 4.3.3. These kinds of measures might not be the most efficient and accurate ones, but they could be used until the basic problems that hinder further measurements are solved. Because measurements cannot be used at this stage at PDU/PAY, they are not further discussed. However, it is strongly recommended to evaluate the possibilities of measurements when the process baseline is set.

7.3.1.4 Synchronisation Between Processes (7.1.2.4)

The arguments claiming that processes are badly synchronised were validated through the quantitative study. First, the responses to question 16 (7.2.16) indicate that 90.6 percent of the respondents are not satisfied with this issue. Further, one respondent argued that changes occur without consideration of the stakeholders when changing a process.

In question 7 (7.2.7), most respondents argued that they discuss process-related issues with other people. With the knowledge that processes are poorly synchronised with each other, it seems like these discussions do only relate to issues that are specific for the process or department. This indicates that people generally are good on communicating within the departments, but they are not very good at discussing with people from other departments or processes. Many problems are often divided between several departments, units, or processes and hence the interaction between departments and units must become much better.

In question 20 (7.2.20) and 21 (7.2.21) where synchronisation was weighted as the most important problem area, and in question 21 (7.2.21) where interfaces between departments was weighted as the third most important problem area supports the above discussions. Thus, synchronisation and cooperation between departments must be seen as one of the most urgent problems that must be resolved.

It was very interesting to see the differences between roles in question 15 (7.2.15) and 16 (7.2.16), where project managers and sub-project managers are the ones that are most negative to synchronisation and understanding between departments and processes. Could these deviations between roles be caused by that project managers and sub-project managers have an overall view and see the problems with interaction between departments and units while the staff just sees their little part?

7.3.1.5 Baselineing/Anchoring (7.1.2.5)

Baselineing (3.2.3) and descriptive modelling (2.3.2) were discussed in the theory chapters and were mentioned as a key activity in process management. The people at PDU/PAY seem to support this statement, both the qualitative study and the quantitative study (7.2.21) showed the need for anchoring the current way of working. Something that is very interesting in this answer is that staff and project management thinks that anchoring is the most urgent measure while line management thinks that this is the least urgent measure.

Further, people in the qualitative study and the open ended question in the questionnaire (7.2.25) argued that processes were forced on them without involvement from staff and without having the process well anchored in reality. This is supported in question 13 (7.2.13) and 14 (7.2.14) in the quantitative study, where the respondents answered that the wrong people develop process descriptions.

According to question 13, people believes that management develop process descriptions. Further, if management believes (7.2.21) that processes are anchored among the personnel while the staff states that they are not, it is a problem that must be resolved. Therefore, anchoring the current way of working with the involved personnel seems very important.

7.3.1.6 Holistic View (7.1.2.6)

Create a holistic view of development was mentioned as important in the qualitative study. Nevertheless, according to question 21 (7.2.21), the respondents argue that creating a holistic view is not seen as very important. One reason for this could be that the respondents did not understand the word "holistic". The word was chosen due to that it was used several times in the qualitative study by respondents but later discussions have shown that everybody might not have understand that option fully.

However, as the literature stated (2.1), a holistic view comes as a side-effect when introducing usable processes in an organisation. Therefore, it does not matter whether people do not consider it as very important or did not understand the word; they will receive it anyway if process management is conducted the right way

If the discussion about what is causing the differences between project and sub-project managers (as discussed in 7.3.1.4) and other roles is valid, a holistic view is something that must be incorporated to all personnel. If it is, staff also will see that their problems might be rooted in some other department or process and hence they could solve this issue so that the problem will not occur in future projects.

7.3.1.7 Documentation (7.1.2.7)

The respondents in the qualitative study argued very much about the documentation of processes and mentioned almost everything as problems regarding the documentation of processes. The quantitative study showed a slightly different opinion. Question 21 (7.2.21) showed that this factor was the absolutely least mentioned factor as a threat to successful process management. However, this could be caused by

that the other factors in that question are seen as even more important. When looking at other questions (e.g. 7.2.11, 7.2.13, 7.2.14), it shows that this most probably is the case. However, as question 3 (7.2.3) shows, the opinion whether the descriptions have an adequate level or if it depends on which description is divided in the organisation.

Some respondents have complained about that the documentation is excessively extensive. This was stated both in the qualitative study and the open quantitative question (7.2.25). Further, it seems like workflow is the most important way of documenting the processes, which was also supported in literature (2.3.2.2). This type of documentation is also very good for defining entry and exit criteria between processes. Hence, to be able to synchronize processes effectively, workflow commonly agreed between departments (2.3.2.1) is the first measure to take. When documenting these workflows, it is important to consider the issues presented in 2.3.2.2 in order to inspire the process users to use it.

7.3.1.8 Adaptation (7.1.2.8)

Adaptation (tailoring) of processes, was discussed and considered as important during the qualitative interviews and in the theory (2.3.2.2). It was also rather highly ranked in question 21 (7.2.21) in the quantitative study (after the already proven important factors: interfaces, synchronisation, and anchoring). This issue is something that is necessary to take into account when documenting the processes. Therefore, this issue is further discussed together with documentation.

7.3.1.9 Clearly Defined Roles (7.1.2.9)

Clearly defined roles was frequently mentioned as a very important issue in the qualitative study. However, the result of the quantitative study (7.2.22) showed that this was not something that was a common opinion at PDYU/PAY. In the quantitative study, it was only ranked as the third important factor out of six possible.

7.3.2 Further Issues in the Quantitative Study

Beside the issues that were mentioned in the qualitative study, there were some issues that were brought up during the quantitative study that were interesting and worth further discussions.

7.3.2.1 Management Commitment

Management commitment (providing time, resources etc.) was a factor that was highly ranked in question 19 (7.2.19). It was also ranked as the most important of all success factors in the study that was presented in 3.3. Further, one respondent argued that management tried to shortcut the process whenever a project becomes critical. He further argued that it would be nice to hear that when a project becomes critical that it is the most important time to follow processes (7.2.25). This problem must be solved in order to have successful process management at PDU/PAY; if not management believes in the processes, their staff will not.

Time was something that was not mentioned specifically in the qualitative study. However, time was mentioned in relation to other tasks repeatedly and therefore it was designed into the quantitative study. Further, people in the qualitative study often asked about what they should report their time on when being interviewed. In the quantitative study, both questions 9 (7.2.9) and 10 (7.2.10) clearly indicated that not enough time is devoted to structured solutions to problems, especially among the staff. This indicates that staff really wants to devote time on process activities, but management does not provide the right amount of time and resources. Further,

questions 13 (7.2.13) and 14 (7.2.14) show that the common opinion among all respondents (including management) was that staff should be more involved in process management.

7.3.2.2 Process Users

Questions 4 (7.2.4) and 5 (7.2.5) indicate that it is not the staff that uses processes but rather management and quality personnel. The question in this case is to ask oneself whether the processes are intended for staff, or management and quality personnel. Further, this could be an indication that processes are seen as something that should satisfy management and not as an aid in the actual development of software. If this is true, the focus does not seem to be on the added value to the business (3.2.4) but rather on achieving some sort of certification or standard.

7.3.2.3 Roles Performing the Process Work

According to the answers of questions 13 (7.2.13), 14 (7.2.14), and 19 (7.2.19); wrong persons develop the process descriptions at PDU/PAY. The answers clearly indicate that most people do not consider staff as being a part of the development, but the majority of the respondents (92.1%) says that staff should be a part of this activity. These figures clearly indicate that the wrong persons develop the process descriptions and staff want to be a more active part in the development. Further, the figures indicate that staff wants to use process descriptions more in their work so that process descriptions are not something that just management and quality persons should use (7.3.2.3). An open response further strengthens this argumentation; *“These developers do not have an understanding of how people work in reality”*, which means that if usable process descriptions should be developed, the affected staff *should* be a part of the development. The issue of affected users involved was very much discussed in the theory chapters (chapters 2 and 3), and user involvement was ranked as number two after management commitment in the study of critical success factors in process improvement (3.3).

7.3.2.4 Differing Answers Between Roles

A clear trend within the answers is that different roles tend to answer differently to questions, especially line management and staff. Team leaders are the ones that do not have a clear trend in any direction, they tend to answer similar to different roles on different questions. The big question is why the answers differ between roles. The initial reflection is that there are not only problems with synchronisation and interfaces in the horizontal way (departments, units etc.) but also in the vertical way (management levels) of the organisation.

7.3.2.5 Training and Communication

Training material was mentioned as a low prioritised issue in question 22 (7.2.22). This might be a little bit surprising at a first glance. The question is however, what the respondents mean by training material. If training material is interpreted as books or websites that explains the processes, it might not be very surprising. If they are interpreted as communication of processes, it is more surprising. Due to this discussion, we cannot be sure of the interpretation and therefore this answer is not further discussed.

Communication and teaching of processes (7.2.23), on the other hand, have some interesting answers. It varies a lot between management persons and staff whether they like role-plays as a communication medium. This could depend on that management people have more experience in training such as teambuilding, leadership, group dynamics and so forth, where this kind of training is more used than in other

contexts. However, when looking at all answers, it could be seen that people prefer alternative methods to presentations as a vehicle of knowledge sharing about processes (7.2.23).

7.3.3 How the Findings Relate to the Requirements Problems

An interesting question is which of the problems in the requirements process (5.4) that are similar to the general process problems that were discussed above. Below follows a short comparison of the identified problems.

7.3.3.1 Traceability (5.4.1)

Traceability is an area that could benefit from the discussions above. Much of the traceability in software is vertical (i.e. the traces from one phase to another). Therefore, different stakeholder's opinions of what they need in traceability are important to consider when developing which traces that must be present. This includes cooperation between departments/units and processes.

7.3.3.2 Involvement in Elicitation and Definition (5.4.2)

Involvement is another area that is affected by cooperation between departments/units and processes. It must be specified which parties that must be involved in the different activities and this must be done through cooperation. For example, the authors of the requirements specification does not know which people that want to be a part of these activities and therefore, discussions about this issue must be held.

7.3.3.3 Change Management (5.4.3)

This area is not much affected by the general process issues that have been discussed. However, the same principles apply as in the previous section where the right people should be present when changing a requirement.

7.3.3.4 Undefined Interfaces (5.4.4)

Undefined interfaces are directly related to the discussions about synchronisation of processes and interfaces between departments/units. Therefore, if synchronisation of processes is successfully conducted, this issue will be solved.

7.3.3.5 Documentation of Requirements (5.4.5)

Documentation of requirements is another issue that is not isolated to the ones that creates it. The process of creating the requirements specification might be designed by the authors of the specification but the demands on the specification must be set by other stakeholders together with the authors.

7.4 Summary of Chapter

This chapter presented and analysed the findings that were made in the two studies conducted at PDU/PAY. Many interesting observations were made within these studies. According to the result of the two studies, the following areas are the ones in most need for improvement:

- Management commitment, management must provide time, resources etc.
- User involvement, appropriate people must be involved when developing the processes
- Synchronisation of processes, the two largest directly process related problems of today are synchronisation of processes and interfaces between departments

- Change management, processes must be changed accordingly
- Anchoring the current way of working, documenting today's way of working is necessary if people shall relate to and use the processes
- Communication, how processes shall be communicated and evaluated

It also evaluated how the requirements management problems relate to these general process problems. The finding was that all requirements management problems are related to the general problems found in the studies, especially synchronisation and interfaces between processes and departments. Therefore, those problems are very likely to be resolved if the general process problems are solved. Therefore, the requirements management process is used as a case in the improvement suggestion that is made in the next chapter.

Chapter

8

Improvement Proposal

“Knowing is not enough; We must Apply. Willing is not enough; We must Do.”

Goethe

The purpose of this chapter is to reflect over the experiences that have been gained through the previous chapters, and use it to suggest a way of improvement with process management at PDU/PAY. The chapter does not try to solve all issues that were found during the conducted studies, but focuses on the ones that were interpreted as the most urgent ones. A proposal of how to solve these issues are presented, which provides an essence of how process handling could be performed in the future.

8.1 Introduction

Today, the telecom industry is idling, when and where the industry will push forward again is not known but it will probably happen. Therefore, a possibility for improving the way of working in the telecom industry is present. If PDU/PAY use the situation to improve when the telecom industry idles, they will come out ahead when the speed of the telecom industry is rising. The result of the studies conducted in this thesis project should work as support for finding the most urgent measures to take at PDU/PAY, in order to improve.

If trying to solve all the issues that were encountered in the studies, much time and effort would have been needed. Therefore, the focus in this chapter is put on the vital few matters that were found most urgent to resolve. Further, the areas of improvement have been divided into two different sections. The first section (8.2), discusses problems that are related to organisational issues and is primarily targeted at managers. These problems are such that should be solved in order to have successful process management. The other section (8.3), discusses problems related to actual process work, and is targeted at the persons that are devoted to perform process related work.

This chapter is based on the discussions that were presented in chapters 2 and 3, and the discussions in these chapters should always be taken into consideration when handling processes and process improvement. However, the intention of this chapter is not to pinpoint every aspect that was brought up in these chapters. The inten-

tion is to give advice about organisational aspects as well as techniques for how to solve process related problems. Therefore, readers who should perform process related work are strongly advised get information about the areas that were discussed in chapters 2 and 3 to get the foundation to perform successful process related work.

The improvement lifecycle that was discussed in section 3.2 is not followed blindly, but it is of course taken into consideration. The current structure at PDU/PAY was presented in chapter 4 and when it is suitable, references are given to this chapter in order to highlight a good way of working or identify opportunities for improvement.

The intention with this chapter is not to give a package with solutions that solve the issues in chapter 7. Instead, the chapter aims to give PDU/PAY an essence to start from. This essence is presented through examples of how such solutions could look like. Further, the solutions that are presented are unfortunately not calculated through a cost-benefit perspective, and the proposal might be adapted in order to handle the processes most efficiently. It is strongly advised that a cost-benefit calculation should be done before these kinds of solutions are put into practice. However, with the proposal given in this chapter, PDU/PAY has a foundation on which further process work could be discussed.

8.2 Organisational Issues

Some organisational issues were found as critical through the studies that were performed (chapter 7). Organisational issues are those that are not directly related to the actual process related work, but are a pre-condition for it to be performed well.

8.2.1 Management Commitment

Management commitment was something that was highly ranked in the studies (7.3.2.1), and must be taken seriously. The research that was presented in section 3.3 also ranked management commitment as the most important factor in process improvement. It is important that management commits to process management for two reasons. 1, People get the time and resources to improve their way of working. 2, People that shall work with processes see that management appreciate their work and becomes more motivated to do a good job.

The second reason above also implies that management should be the ones that promote and mission processes. Remember 7.2.25, where one respondent stated that management tries to shortcut the processes whenever the projects go critical . If the organisation wants people to use its processes, this problem must be resolved instantly. If management does not see the need for process descriptions and they tell their staff to abandon them, it is no use developing process descriptions at all.

However, management commitment should not be interpreted wrongly. One could interpret management commitment as management performing the improvement work and solve all problems. This is not the right way, see question 13 (7.2.13) and 14 (7.2.14), where it is shown that today management develops processes, but people at PDU/PAY definitively have the opinion that staff should do it (often together with management).

8.2.2 Administration of Processes

Change management of processes was seen as important both in the literature (2.4) and in the conducted studies (7.3.1.1). As stated in the chapter about processes at PDU/PAY, no effective change management of processes was present (4.2.5). However, an initiative that aims at the right direction is the system with process owners (4.2.1). These owners is a start on a system where one person has the responsibility for each process and where people know whom to contact in case of problems or other issues.

A question that might be raised in this discussion is whether line managers are the appropriate people for having this role. A line manager has often several other responsibilities and this could cause conflicts between line-, project-, and process activities because the line manager provides resources to all instances. Therefore, it is suggested to have other persons than line managers as process owners. The suggested person to overtake this role is a line-based person with good insight in the daily work. It is important that this person has:

- a clear responsibility of the process
- good knowledge in process related work
- the process as his primary responsibility
- resources to perform process related work
- good communication with other process owners
- knowledge about the process and the people in the process

This way, this person can talk the same language as the process users and update the process description if something is wrong. Even if the different process owners have a good relation in-between, it is important that a main-process owner is present in order to prevent problems of coordination, communication, and authority (Nicholas 2001). Someone at the department that is in charge of the process web (4.1) is suitable as the main process owner, both in terms of their knowledge about the processes and because they already are the main administrators of the web.

It is urgent to solve the issue of change management because the processes at PDU/PAY today are often created and then forgotten about (7.1.2.1). If processes shall be followed, they must reflect the actual way of working, people find new solutions to problems all the time and these must be reflected in the process descriptions (2.4). One of the main intentions with processes is that they are a way of sharing knowledge within an organisation (2.1); if the descriptions do not reflect this knowledge, they are not very useful.

If fixing this issue, the responsibility is transferred to people who have more time devoted to the processes, and prioritises processes as number one (even if it might not be a full-time work). If having process owners that are good at their work, improvement projects might not even be needed because of that the process changes itself accordingly.

8.2.3 Software Engineering Process Group

When comparing process related work at PDU/PAY (chapter 4) and literature (3.2.1) it is obvious that PDU/PAY does not have a process group. All process related work seems to be conducted by the owners of the process together with some arbitrary selected work group. Neither the owners nor the work groups have any formal training in process related activities. This way, the quality of the work is very diverse between which people conducting the work, and could often be better performed. Because of the nature of the specific problems (which are discussed in 8.3), the process group people need special qualities.

The people in the work group must have good social qualities, they must be good at handling people and they must be able to elicit everyone's opinion. This is not something that all people have as a natural talent. The question is whether to hire people that are good at these tasks or to educate people at PDU/PAY in moderation techniques (e.g. Metaplan 2002). The discussions in 3.2.1 indicated that the best solution is to have a mix between outside and inside personnel in the work group. PDU/PAY, on the other hand, do not want to hire external consultants due to their negative experience with such (4.2.1).

With the relatively large numbers of sessions that the process group must attend, it might be most cost efficient to educate people within PDU/PAY in moderation matters. It is suggested that two persons get this education, and then they will work full time with these matters as a starter. If the problems with interfaces and synchronisation should be solved, it is important that people are trained in these issues. The cost of not solving these problems, is that the processes will be developed the same way as today, with a work group of people interviewing a couple of persons and then creating a process. The studies showed that the personnel viewed this as a wrong way to develop processes and the consequence became that the process descriptions were not used (chapter 7). With trained people on this task, valuable information will be elicited about how the processes shall work and then be documented and used.

8.2.4 Evaluation of Processes

Evaluations of processes were seen in 4.3.2 as something not very well handled, with processes seldom evaluated. If they were, the information seldom reached the owner of the process. This could be caused by several reasons, one might be that people did not know that the owner of the process wanted this information, another might be that the owner of the process did not show interest in the information because of other priorities.

However, there are evaluations conducted in some projects and those must be encouraged to be used. Evaluations are a good way of sharing the experience that has been gained in the projects, and the persons that are educated as moderators (8.2.3) should preferably be present. Experience with this kind of post-project evaluation has shown many positive aspects. Nevertheless, it is important that the process owners are an active part and encourage that evaluations shall be conducted. Further, owners must show that they really want to take part of the experience gained.

In addition to the above discussed post-project evaluations, continuous process evaluations are suggested. These evaluations should be conducted at a periodic basis (e.g. once a month). At such an evaluation, the process owner should collect staff from each project that uses "his" process, and call for a workshop where prob-

lems, improvements, new techniques etc., are discussed. If the process is scattered between many process owners (e.g. the requirements process), each sub-process owner should have such a workshop with “his” people before discussions with other sub-process owners and main process owner are held.

With this approach, processes are evaluated once a month together with staff from all projects and then discussed with people from other processes. This way, processes could get updated continuously in order to make the process descriptions reflect the correct way of working. Process descriptions are also updated more often, which leads to that when processes should be improved, much work is already done. For example, there is no need for establishing a process baseline (3.2.3) because it already exists.

8.3 Process Related Work Issues

Beside the organisational issues discussed in the previous section, some issues that are directly related to the work with processes are found as critical. The areas that were discussed in the previous chapter as important were: synchronisation of processes, interfaces between departments/units, and anchoring the current way of working. Because work methods at PDU/PAY are rather rooted; synchronisation, interfaces and anchoring could be put together to one activity, which is explained below.

For anchoring the current work procedures and synchronising the processes, an artefact-based technique is suggested. This technique is built upon the discussions that were made in 2.3.2.1 where analysis of documents and artefacts were suggested. This technique was selected because communication between departments and processes were found as a important issue to resolve (7.3.1.4), and communication around certain artefacts and documents might solve these problems.

A six-step technique has been developed within the context of this master thesis in order to define and anchor the current way of working, at the same time as the interfaces between departments and processes become clear and agreed upon by all stakeholders. The focus is put on documents, forums, and the workflow of them. Further, the technique facilitates a kind of customer-developer relationship where requirements are set by the people who are receivers of the work result.

The technique is described in section 8.3.1 to section 8.3.6. All examples that are made in these sections originate from the requirements process (chapter 5). However, the intention is not to solve the current problems with the requirements process, and the information assumed in the examples might not be accurate. Thus, it should really just be seen as examples.

8.3.1 Identify the Stakeholders and the Artefacts

The first step is to identify all stakeholders of the process. In the simplified requirements process (chapter 5), these stakeholder are: Customers, Strategic Product Management, System Management, Design, IT&SV, and Operation. Note that these departments probably need to be divided into their sub-units in real use of the technique. For the reason of simplicity, this is left out of the scope of this explanation. Further, customers are also left out of the discussions because they are not an active part in the processes. However, to really get as good processes as possible, they might have to be included in some discussions.

Further, documents, forums, and other artefacts that are present in the process need to be identified. This could be done through observations, interviews or some other suitable technique. Figure 5-1 presents the largest forums and documents of the requirements process that were found in the RM-project (through interviews), the following discussions are based on these.

8.3.2 Conduct a Workshop with each Stakeholder around the Artefacts

The next step is to investigate which stakeholders that are affected by which document(s) or forum(s). At this stage, the moderators that were discussed in 8.2.3 should enter the project. The software engineering process group then prepares and books time with each stakeholder that was identified in 8.3.1 to have a workshop. Most important is that all projects the department/unit is involved in are represented and that the persons that are selected are representative for his department or unit.

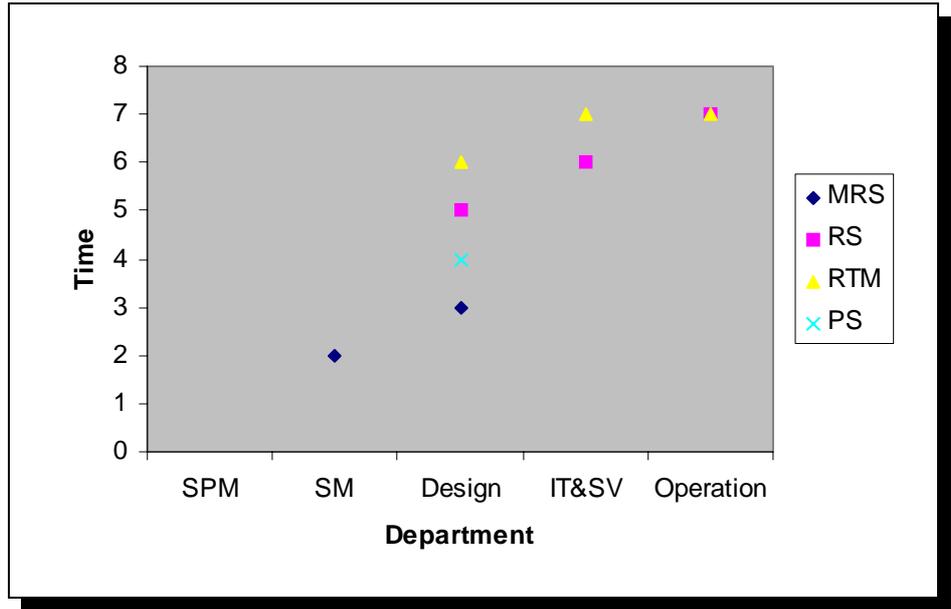
In this workshop, the moderators lead a discussion around the documents and forums of which the participants are affected. Here, it is important that the participants get the chance to express which artefacts that they want an active role within and not only discuss what artefacts they are involved in today. For example, section 5.4.2 discussed the problem with that different stakeholders want a more active role in the requirements process. In such a workshop, these stakeholders should get the chance to really express what requirements they have on the process.

When all artefacts that the stakeholders are (or want to be) a part of are identified, each artefact should be discussed in detail. Here, the participants of the workshop should express their requirements on the artefact. Such requirements could be:

- Content, what information does the stakeholder need?
- Producer/Participants, who is the appropriate person to create/be involved?
- Timing, when does the stakeholder need it?
- Distribution, how does the stakeholder want it?

With this information at hand, it is possible for the process group to create views of every artefact. For example, a time chart could be created where each document is present and the requirement of delivery time from each stakeholder-group could be presented (Figure 8-1). Last, each group should get the possibility to express if they miss any document and for what such a document should be used.

Figure 8-1: Time line for documents. Note: this figure might not correspond to reality, it is just for example purposes.



8.3.3 Conduct a Workshop with all Stakeholders around the Artefacts

The next step is to create a workshop around each artefact with participants from all the affected departments/units that were discussed in 8.3.2. In this session, the moderators get a more active role in the work and they should act as moderators between the people that are involved. The purpose of having these neutral moderators is because it is easier to create a Win-Win relationship (2.3.2.1) with all participants as winners. At this workshop, the intention is to create unity between all participants based on the requirements elicited in 8.3.2.

These workshops should not involve all people that were involved in the previous workshop from each department. Instead, the process group should try to invite suitable persons from each workshop. Two persons from each individual workshop might be suitable for representing the department/unit. These sessions should not take more than two hours because the requirements from each department already are set. This way, the workshop is more aimed at communication, understanding and discussions about the details. Of course, some differences in opinion could occur, and in such case, more than two hours might be needed to solve the problem.

8.3.4 Model the Process

When the workshop sessions are conducted, it is time to model the process. At this point at PDU/PAY, it is important to model the workflow with entry and exit criteria (7.1.2.7). Now, the focus is switched from the artefacts to the department's individual processes (e.g. test process, design process). However, this is not valid in all cases, forums like Configuration Control Board and such are developed as support processes to all the other processes.

As an example of how the process could be documented, the process of System Management is used, based on the information that is present in chapter 5. In this process, the entry criteria had been discussed as a Main Requirements Specification that was delivered in a certain time and with the agreed information between the stakeholders (in this case System Management, Design and Strategic Product Management (Figure 8-1)). The exit criteria are defined as Requirements Specification, Requirements Traceability Matrix, and Protocol Specification. With the time line presented in Figure 8-1, it is possible for System Management to focus on the right things in the right order.

The above discussion will probably solve the problems with vertical processes as discussed in 5.4.4. For example, as Figure 8-1 shows, the Protocol Specification (PS) is the first document that other departments need, this should be ready 1 time unit before the Requirements Specification (RS). Hence, more focus should be put on preparing the Protocol Specification and less focus should be put on the Requirements Specification. This way, Design is able to start their work with an approved Protocol Specification and then go on with an approved Requirements Specification. This would have been much better than to start designing with both the Protocol Specification and the Requirements Specification that are not approved and probably are to be changed.

Because the processes are to be put on the interactive process web (4.1), it is possible to provide even more information about each exit criterion. It is possible to create a link to each of the above discussed documents. When clicking on such a link, exit criteria for that specific document could be provided. Such exit criteria could for example be to whom it shall be distributed, when each department need to get the document, and so forth. One of these exit criteria could be that the Requirements Specification shall be reviewed, which is made by the Technical Committee. If providing a link from the exit criterion that says that it shall be reviewed to the definition of the Technical Committee, it is possible to document issues like who shall be involved, how much preparation people need, what the result shall be, and so forth in the Technical Committee description.

People have also expressed wishes for more interactive processes (7.2.25), and the above discussed technique should be a good start for this. However, other information (e.g. guidelines, templates) than workflows with entry and exit criteria might also need to be documented, but the most important ones today, are the workflows with entry and exit criteria. Other information could most of the time be developed within each process. Roles however, should be defined in the same way as the earlier explained workflows due to that roles often interact with other departments and units. However, it is important that the information that is present at the process web are updated so that people know on what to focus and which steps that must be taken.

8.3.5 Review the Process

When the process is modelled, it is very important that the process is reviewed by the people that are intended to use it. As discussed in 2.3.2.3, it is preferable that only the people that are affected by the process should review the process. With the approach suggested in this chapter, it is already known which people that are affected by which artefacts, and no problems of getting the right people to review it should be present.

8.3.6 Train and Communicate the Processes

With the approach suggested in this chapter, no direct training should be needed because the people that should use the processes have been a part of the development of it (an exception is newly employed staff, which should have training in using the process). However, it is very important that the processes are communicated to the staff. It is not at least important that the staff are informed how they should use the process web in order to take advantage of the processes.

When staff know how to use the process, only communication saying that the new processes are available should be needed. This is preferably performed through workshops according to the staff at PDU/PAY's own recommendations (7.3.2.5). This is a kind of team training that was discussed as effective at teaching processes (3.2.7.1). However, it is recommended to try alternative ways of communicating and training people in using the process, such as role-plays or games. According to studies that have been made, such ways seem to be more effective (3.2.7.1) than ordinary teaching methods (e.g. presentations).

8.3.7 How the Process Work Should be Run

The intention with the six-step approach is that it should be conducted once across the whole process. When this is conducted, the process should be good enough to work according to. In the future, when people encounter that improvements could be made within some part of the process, the six-step approach could be used to elicit the new or changed requirements on artefacts in that part. Hence, the procedure must not include all artefacts because it would have been unnecessary expensive.

The hard thing with doing this work is to decide whom to be process owner of the requirements process. The process is cross-functional and involves all departments and hence one process owner is not suitable as administrator of the whole process. The suggestion is to have the main process owner as a part of the process group through the whole process project. This person together with the moderators is the core of this group. However, it is impossible for the main process owner to document the whole process and then be an administrator of it.

Therefore, when conducting step 8.3.3, it is recommended that the process owner of the process that produces or is responsible for the artefact is a part of the session. This process owner then documents the process together with "his" staff. However, some processes are not a direct part of any sub process (e.g. Configuration Control Board (5.2.2)), these should be documented and administrated by the main process owner as a part of the common processes at PDYU/PAY.

It is suggested that the process group consists of three or four persons depending on which stage the work is in. In the first step (8.3.1), the main process owner together with a couple of persons identifies the stakeholders. At the next step (8.3.2), the moderators and the main process owner collect information about the different stakeholders and their requirements on the artefacts. Further, in step (8.3.3) the main process owner, the process owner of where the artefact is produced, and the moderators are present. In the following steps (8.3.4 to 8.3.6), the process owner of the sub-process conducts the work, together with staff and some reference persons if necessary.

However, most important is to involve staff from all departments and from all projects. This way, the diverse projects (7.2.17) could take advantage of each other's experiences and come up with the best solution.

8.4 Which Problems in the Requirements Process are Addressed?

With the approach suggested in the previous section, several of the problems specific to the requirements process (5.4) are addressed. The problem with involvement (5.4.2) is directly addressed because all departments get the chance to express when they need to be a part of the requirements process. The problem with change management (5.4.3) is not directly addressed but when requirements are put at the Change Requests and the Configuration Control Board, much of the problems could be solved. The problems with undefined interfaces (5.4.4) are directly addressed because they are directly related to the synchronisation between departments.

Documentation of requirements (5.4.5) is an area that is not directly addressed by this technique. However, when the different departments put requirements on the content of the Requirements Specification (8.3.2), System Management gets valuable input for starting an improvement project within their process. Finally, the traceability problem is not something that is directly addressed by this technique. However, when the synchronisation and anchoring of the requirements process are made, a great foundation for starting an improvement project regarding traceability is provided on the set baseline (3.2).

8.5 Summary of Chapter

This chapter reflected over the experience gained through the previous chapters and developed an improvement proposal based on these experiences. The suggested improvements comprised two separate parts; one that considered organisational aspects and one that considered actual process related work. In the organisational part, issues that are handled are management commitment, administration of processes (change management), software engineering process group, and evaluations of processes.

In the part that addresses the actual process related work issues, a six step approach was presented for how to develop processes. This approach is an artefact based approach that sees the relationships between stakeholders of a process as customer and developers. This means that all artefacts that are present in the process are discussed with all stakeholders in order to secure everyones opinion about the characteristics of the artefact.

Finally, it was discussed how this suggestion relates to the problems in the requirements process at PDU/PAY. The result was that two of the earlier discussed issues (5.4) were directly solved, one was indirectly solved while the suggested technique provided a foundation to solve the two remaining problems.

Chapter 9

Epilogue

"You may be disappointed if you fail, but you are doomed if you don't try"

Beverly Sills

In this chapter, the conclusions of the master thesis are presented. It also presents in which areas further work might be needed. Finally, an assessment of the work performed is presented.

9.1 Conclusions

The result from this master thesis was derived from a literature survey, and from a qualitative and a quantitative study. The intention with two studies was to validate the results from the studies against each other. The result was that the two conducted studies agreed well with each other, and they also agreed well with the literature studied.

The problem at PDU/PAY today is that their processes are not always followed as intended. The intention with this master thesis was to investigate why they were not. The reasons that were found to contribute the most were:

Management commitment: Management does not provide the appropriate amount of time and resources for process-related activities.

User involvement: The staff at PDU/PAY were not as actively involved in process-related work as they should. Today, the wrong people often develop the descriptions.

Synchronization of processes: Different processes at PDU/PAY are not always synchronized with each other. This means that two processes that interact do not have interfaces that match each other.

Change Management: Today's process descriptions at PDU/PAY do not always change when the work methods are changed, therefore the processes are often out of date.

Anchoring the current way of working: Today's process descriptions at PDU/PAY are often not anchored among the staff as the current way of working. Instead, many process descriptions are regarded as process utopias that the staff cannot relate and adhere to.

Communication of processes: The staff at PDU/PAY seem to have problems with finding process descriptions because they are not communicated to them.

All these issues were also mentioned in literature as threatening factors for successful process management. Hence, the process-related problems that are present at PDU/PAY are not unique in any way but rather seen as common problems in software organisations. Further, the conducted studies showed that the areas in most need for improvement in the requirements process were tightly related to the above mentioned general process problems.

In order to solve the general process problems, a proposal was presented to give PDU/PAY an essence to improve their process related work from. The proposal contains two parts: 1, an organisational part that aims to provide a foundation for process related work. 2, a process-work related part that is a more hands on method for how to anchor and synchronize the processes. The proposal was derived from the studies done, and is intended as a foundation for how deviations from processes could be avoided in the future. However, cost-benefit analysis has not been made on the proposal; hence, some parts might be adjusted in order to be as efficient as possible.

9.2 Further Work

When conducting this thesis project, several related areas were found as interesting to investigate further. Due to the time constraints, it was not possible to do it in this master thesis. Therefore, a list of interesting further work is presented below:

Communicating Processes: It would have been interesting to investigate how processes most efficiently are communicated and trained. Could alternatives like role-plays and games facilitate the understanding of processes in relation to ordinary teaching methods (e.g. presentations)? Rational Software; for example, has developed a board game for teaching their process (Rational Unified Process), this could be interesting to evaluate for a starter.

Modelling Processes: Today, PDU/PAY are using the process web to present the processes. The web is a good start but there are some negative sides as well. It would have been interesting to develop a more extensive, user friendly and interactive media for presenting the processes. This could give the staff even more help in their daily work.

Process Usage by Demographics: How is processes seen and used by different groups of people (age, gender, education etc.)? Initial studies within this master thesis indicate that differences in opinion between different age-groups and genders are present. It would also have been interesting to investigate how the usage of processes differs between different parts of the software development lifecycle (design, test etc.).

Teaching in Computer Science: How does today's teaching in computer science relate to process oriented thinking and structured working? It would have been interesting to investigate to what level students need teaching about structured working in order to be successful in software development. Many educations might be too focused on technical matters, while only a few seem to take process thinking into account. A personal reflection within this master thesis is that many of the process related problems originate from that people developing software have not been taught to work in a structured way.

Economical Value: An interesting subject for investigation would have been to estimate how the cost of the current process relates to the cost of an improved process. How long time would it take before the discussed techniques is economically justified? The intention with this thesis was to estimate this, but due to time constraints and the complex task to calculate it, it was not feasible.

9.3 Assessment of Work

Although the work with this thesis has been interesting, there are some things that could be done better. These things are:

- Statistical calculations (significance etc.) on the data that were collected should have been done. However, due to lack of knowledge and time, this was not done in this master thesis.
- The thesis could have been more clearly delimited and more focused around some of the issues brought up in order to make the work smaller. However, due to the type of subject, which is rather "soft", and due to the specific issues were not found until the study was performed, it was hard to leave out parts in the discussions.

9.4 Summary of Chapter

This chapter presents the conclusions that were made within the master thesis. The processes at PDU/PAY are not used as much as they are intended to. Through the studies in this master thesis, a number of problems were identified. The issues that were identified were problems that are common in software organisations and a suggestion of improvement to solve these issues was presented. A presentation of further work was also made in this chapter, where a number of interesting areas for further investigation were presented. Further, an assessment of the work performed in this master thesis was presented.

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“The books that help you most are those which make you think the most. The hardest way of learning is that of easy reading; but a great book that comes from a great thinker is a ship of thought, deep freighted with truth and beauty”

Theodore Parker

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Appendix

A

Questionnaire and Graphs from the Study

*"I have but one lamp by which my
feet are guided, and that is the
lamp of experience"*

*Patrick Henry, Speech before the Virginia
Convention (1775)*

This appendix presents the graphs that were produced from the result of the quantitative study within this master thesis.

A.1 Abbreviations

In order to make it easier for the reader to interpret the graphs, abbreviations have been used for the names of the different roles in the questionnaire. Below follows the abbreviations and its corresponding name as in the questionnaire:

QP: Quality Person

PM: Project Manager

Sub-PM: Sub-project Manager

LM: Line Manager

TL: Team Leader

Staff: Other

All: The sum of all respondents of the questionnaire

Mngmnt: Management

A.2 Graphs

At the following pages, the questions from the study are presented in graphs. In questions 1-18 and 24-27, the bars represent how the percentage of answers in each question is divided between the roles. In questions 19 to 23, the bars represent how the meanvalue of answers in each question is divided within the roles (in questions 19-23, the respondents had 100 points to divide among the alternatives at each question). In question 28, an explanation of the answers is made and in question 29, the responses are presented in text. Further, every question is phrased in the heading of its corresponding figure.

Figure A-1: 1. How would you classify your own knowledge about current processes at PDU/PAY?

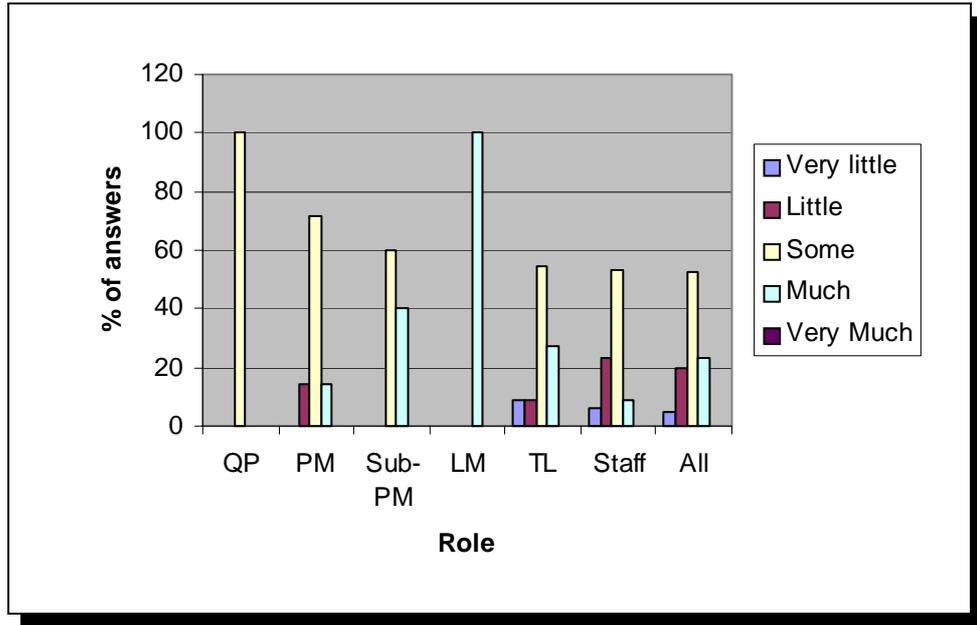


Figure A-2: 2. What is your overall personal impression about the usefulness of today's process descriptions at PDU/PAY?

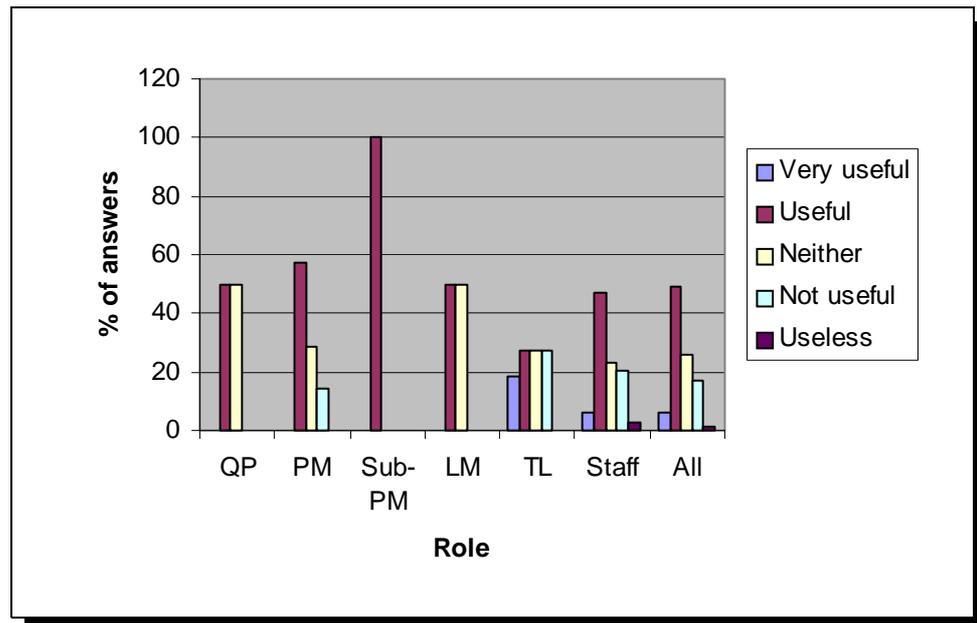


Figure A-3: 3. According to your opinion, how detailed are the process descriptions today?

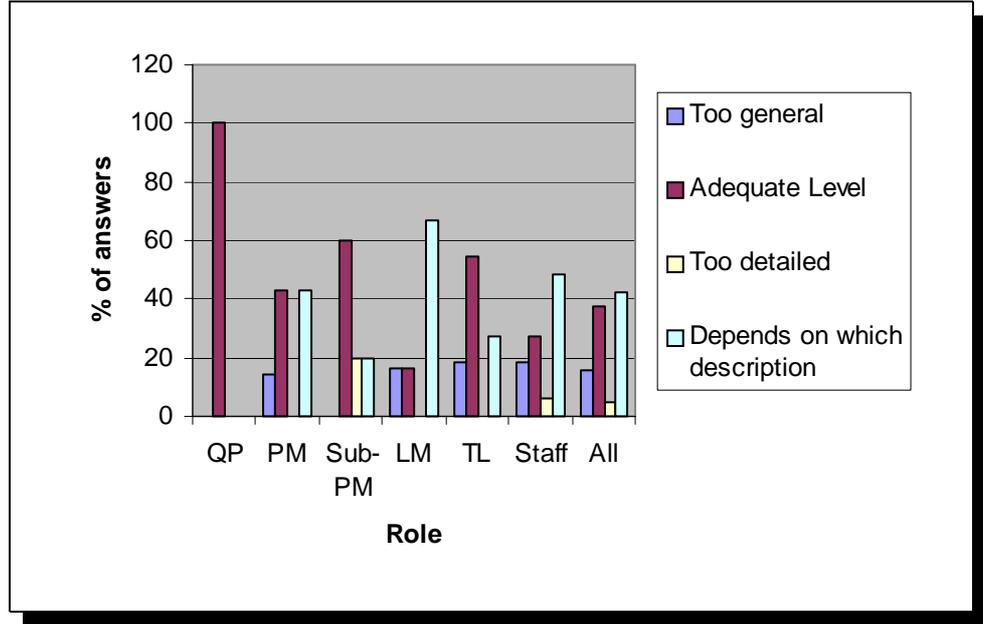
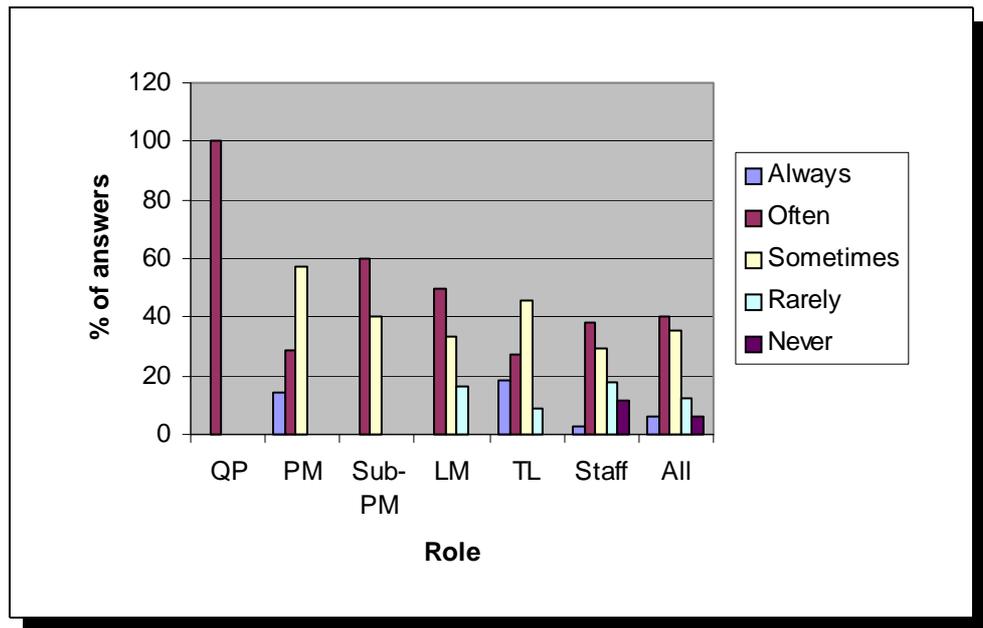
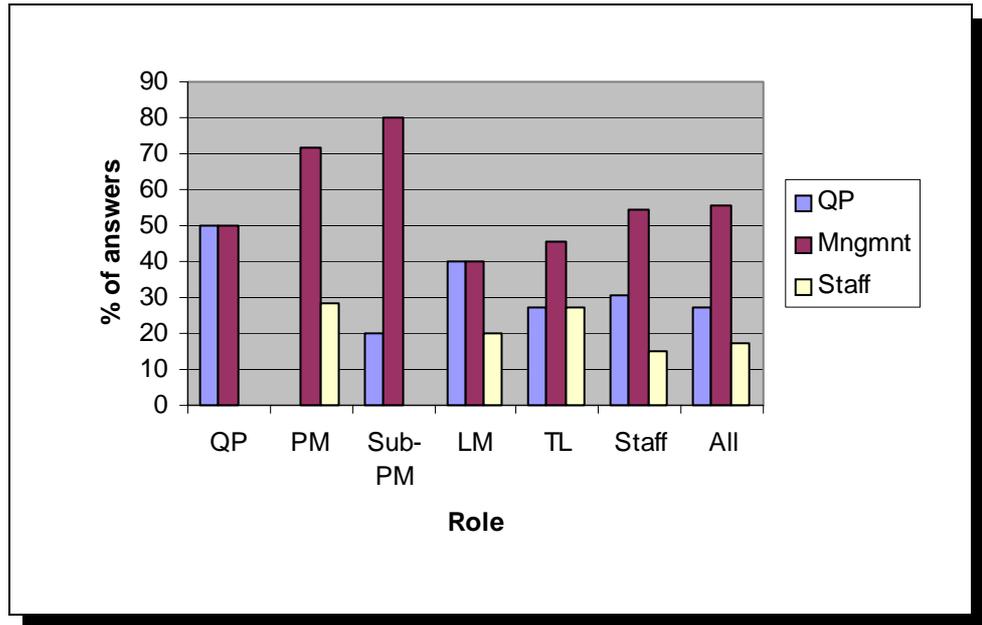


Figure A-4: 4. To what degree do you use processes today?



FigureA-5: 5. Who do you believe are the most active users of process descriptions of today?



FigureA-6: 6. Do you have influence in discussions regarding issues that affect your work (work descriptions, process improvement etc.)?

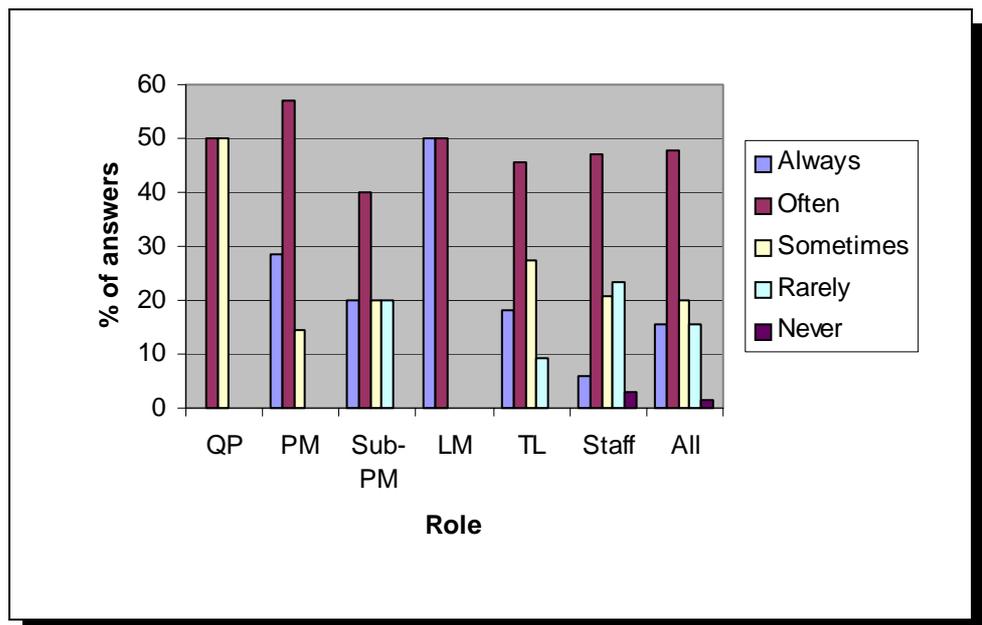


Figure A-7: 7. When you run into a process-related fault that affects other people, do you discuss it with them?

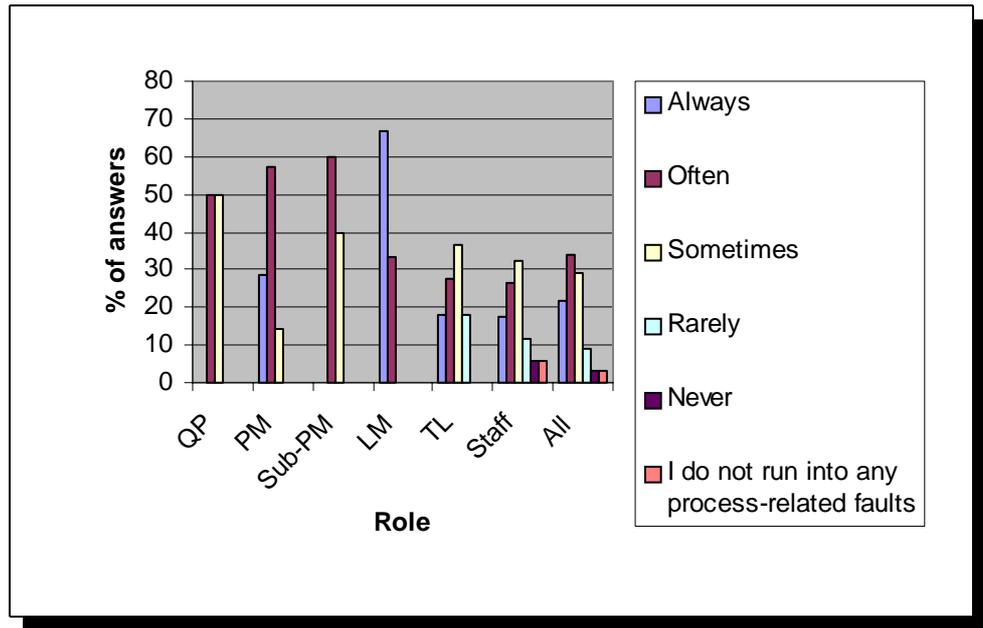


Figure A-8: 8. Does feedback from the receiver of your work results provide you with knowledge in order improve the results?

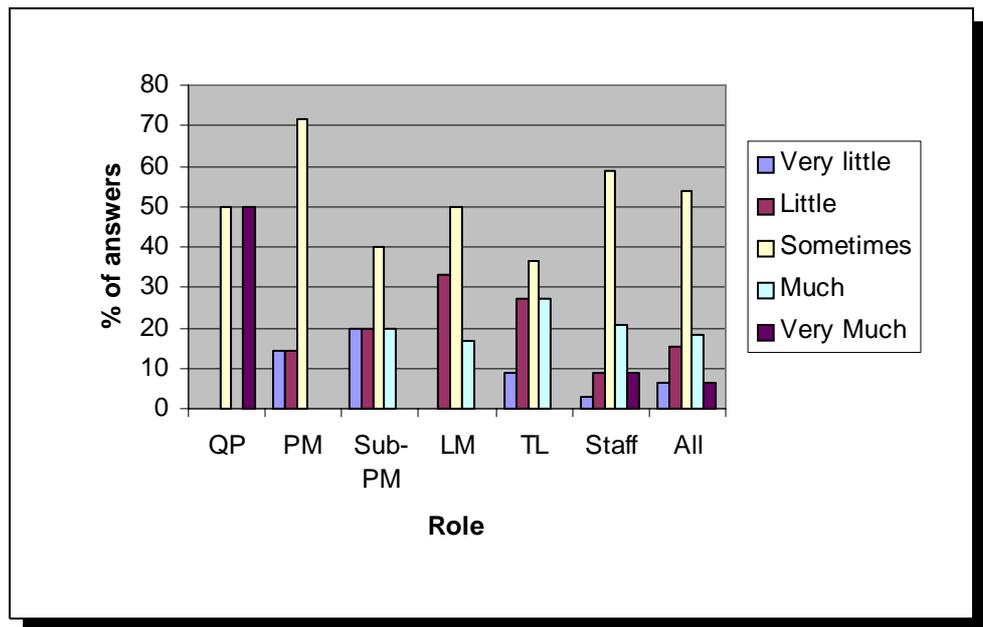


Figure A-9: 9. According to your opinion, is enough time devoted to develop structured solutions to problems?

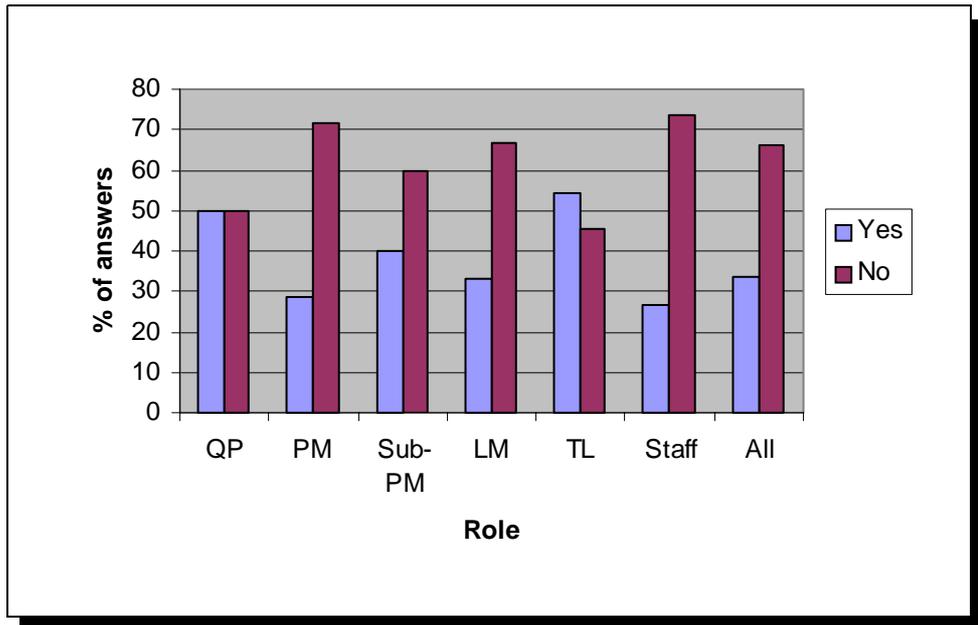


Figure A-10: 10. How much time do you want to devote on process improvement activities?

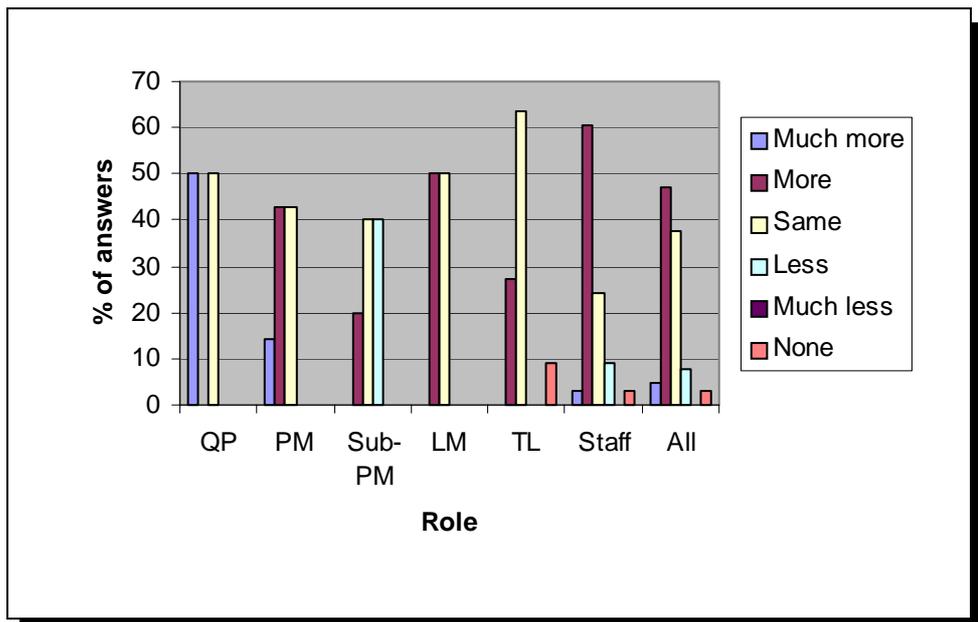


Figure A-11: 11. Are process descriptions updated as often as they should?

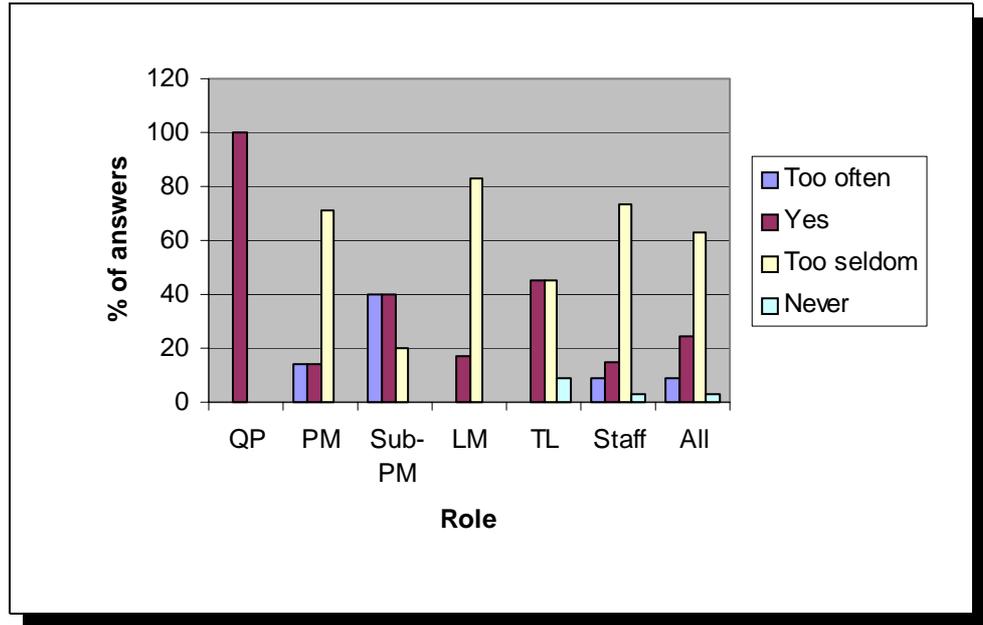
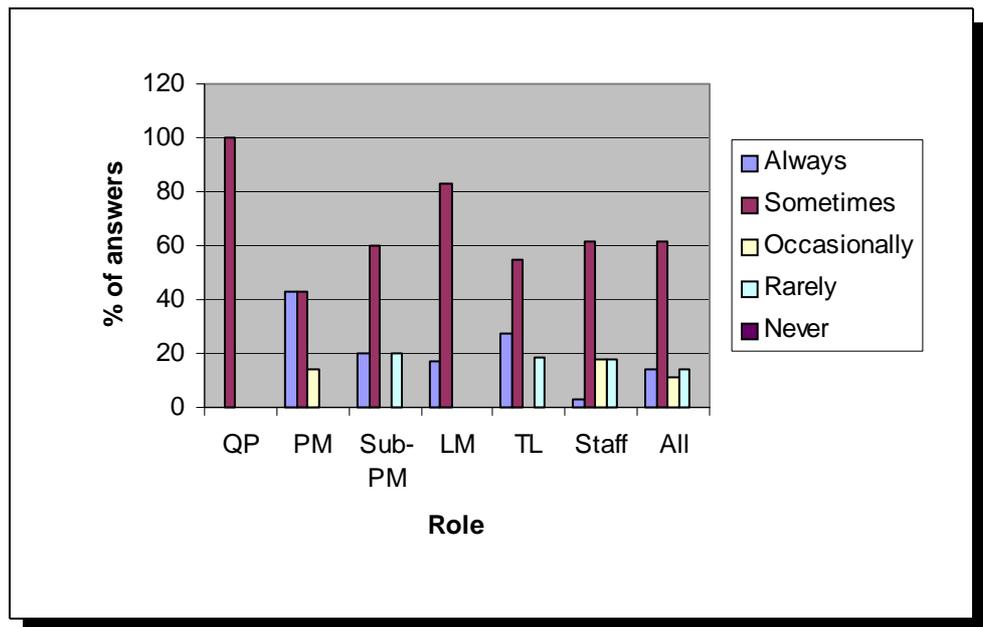


Figure A-12: 12. Do you change your way of working when processes are updated?



Graphs

Figure A-13: 13. Who develops processes and process descriptions today (more than one X is allowed)?

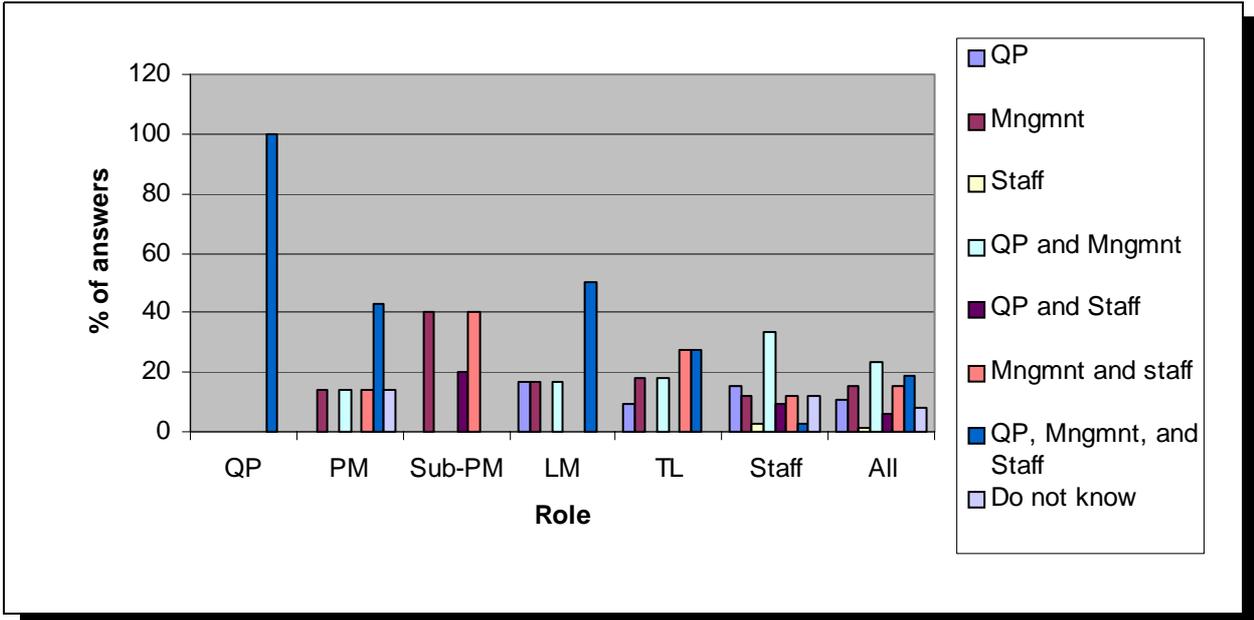


Figure A-14: 14. According to your opinion, who should develop processes and process descriptions (more than one X is allowed)?

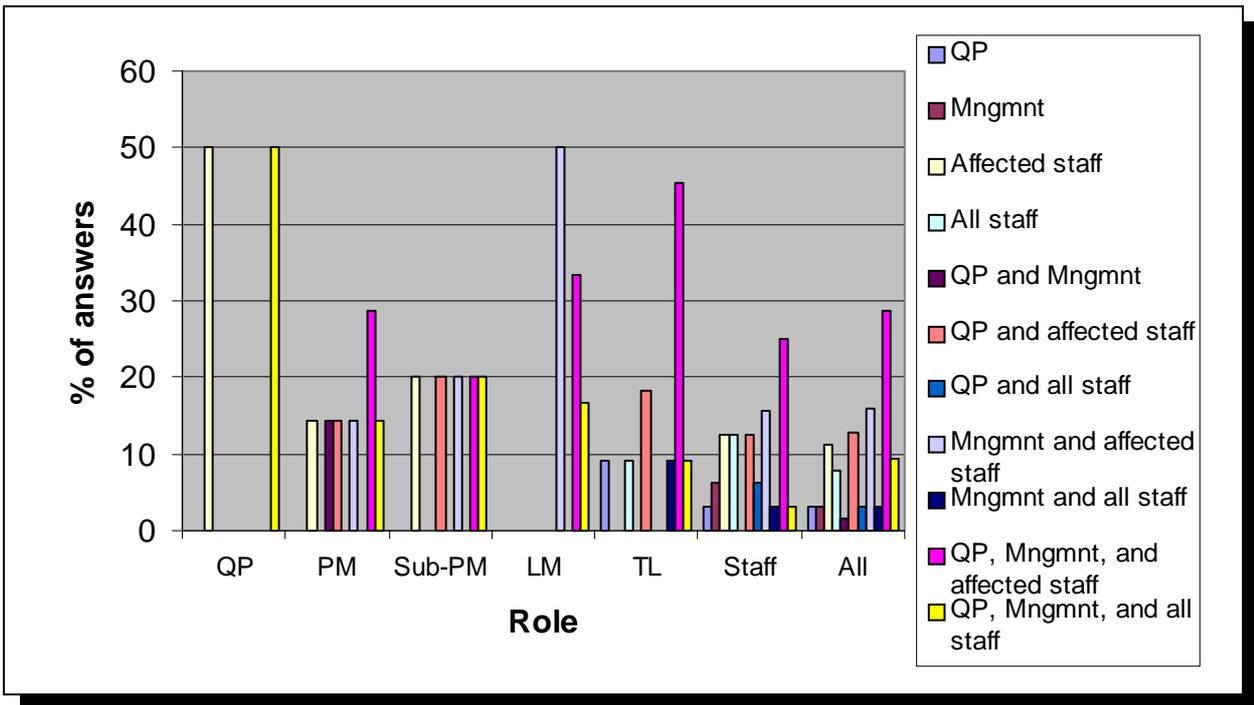


Figure A-15: 15. According to your opinion, do different departments/units have an understanding for each other's work?

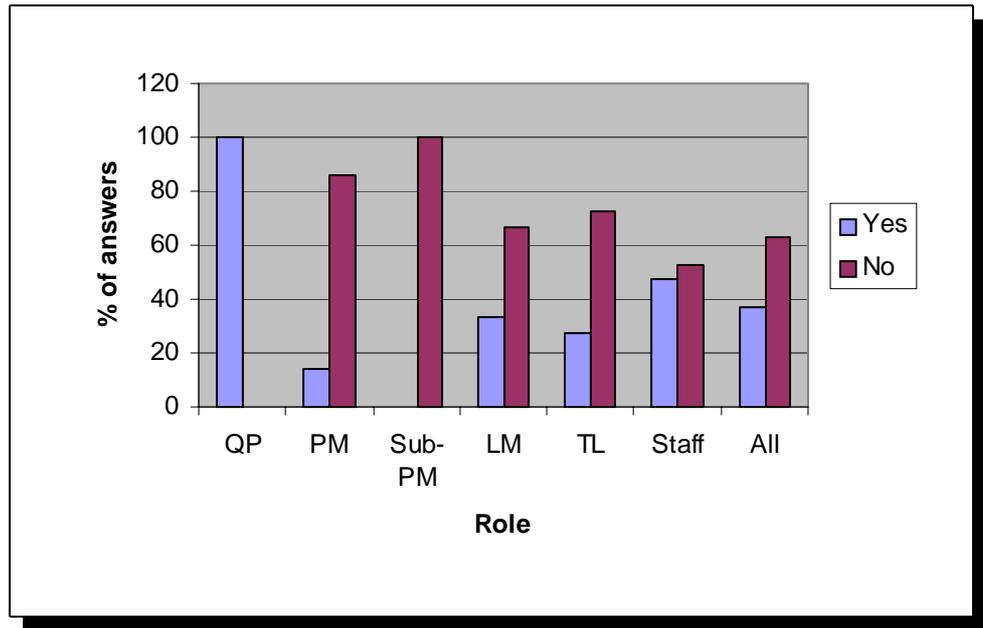


Figure A-16: 16. According to your opinion, how well are different processes synchronized with each other?

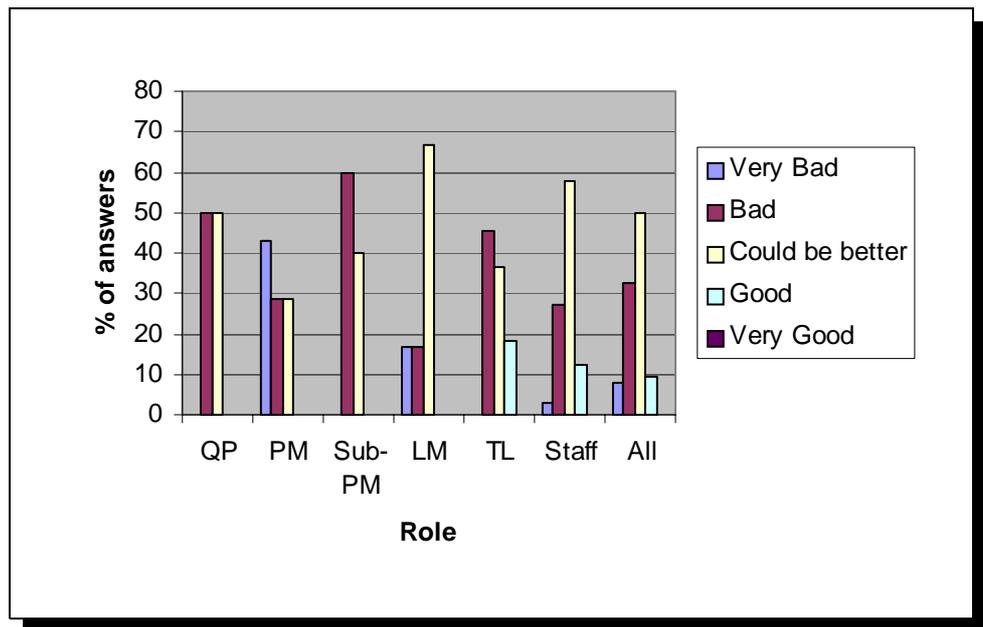


Figure A-17: 17. How similar do you consider the projects to be (regarding work structure, communication interfaces etc.)?

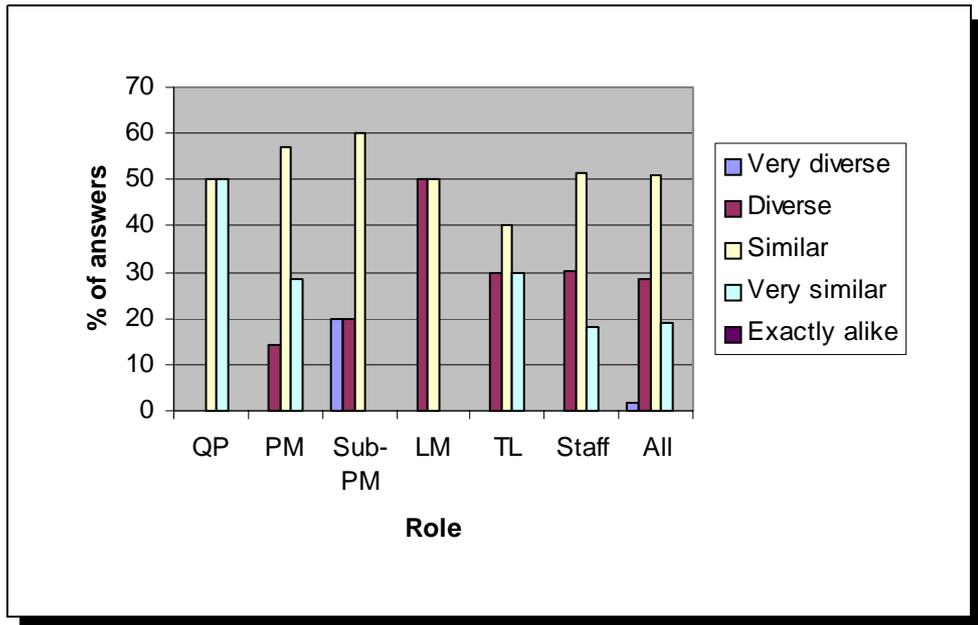


Figure A-18: 18. Spontaneously, what is your immediate feeling when you hear the word “process”?

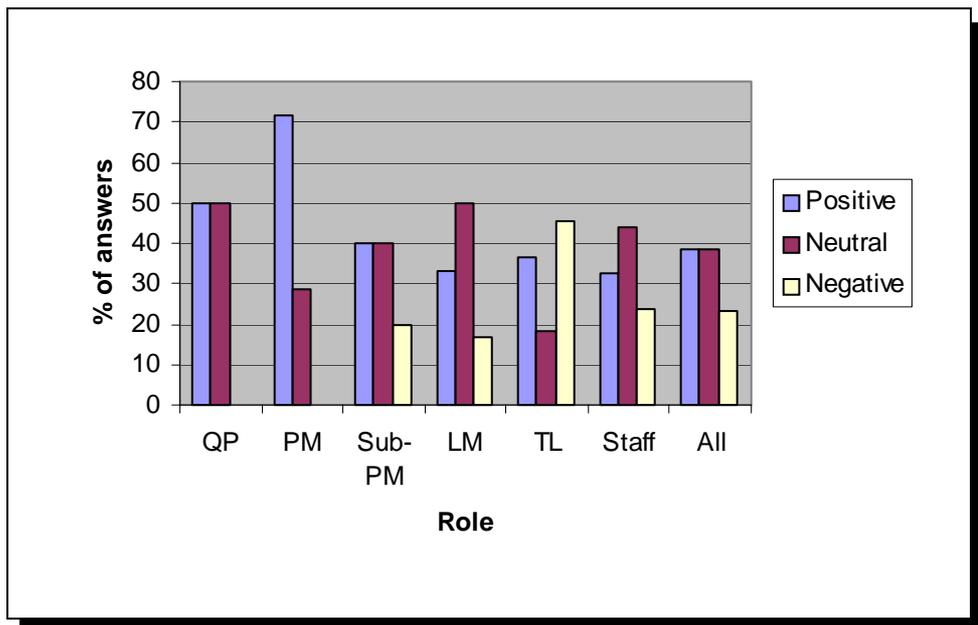


Figure A-19: 19. When conducting process improvement, how is the relative importance divided between the following 5 factors?

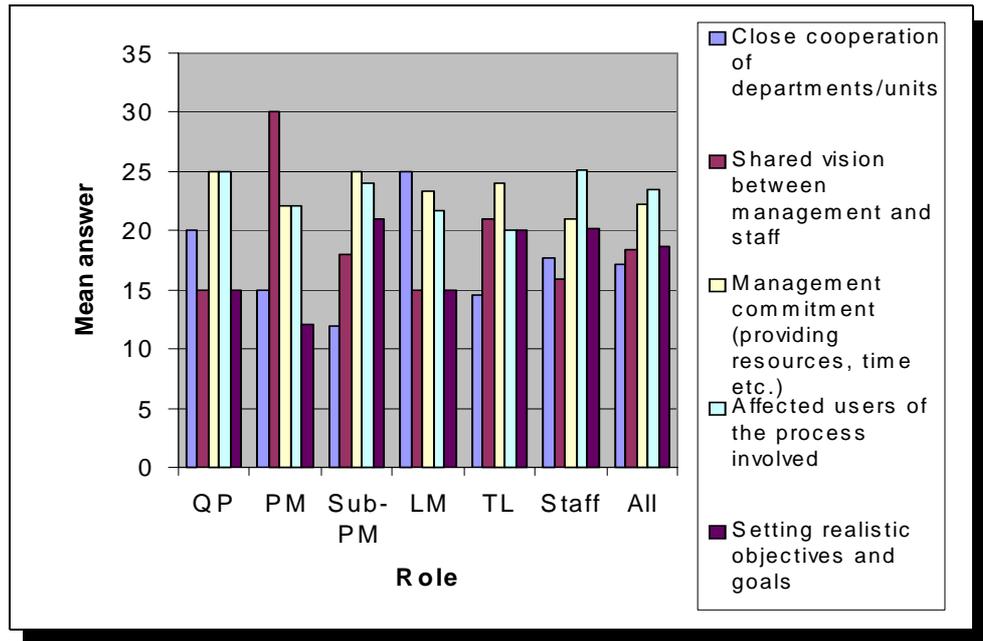


Figure A-20: 20. How is the relative threat against successful process management divided between the following 5 factors?

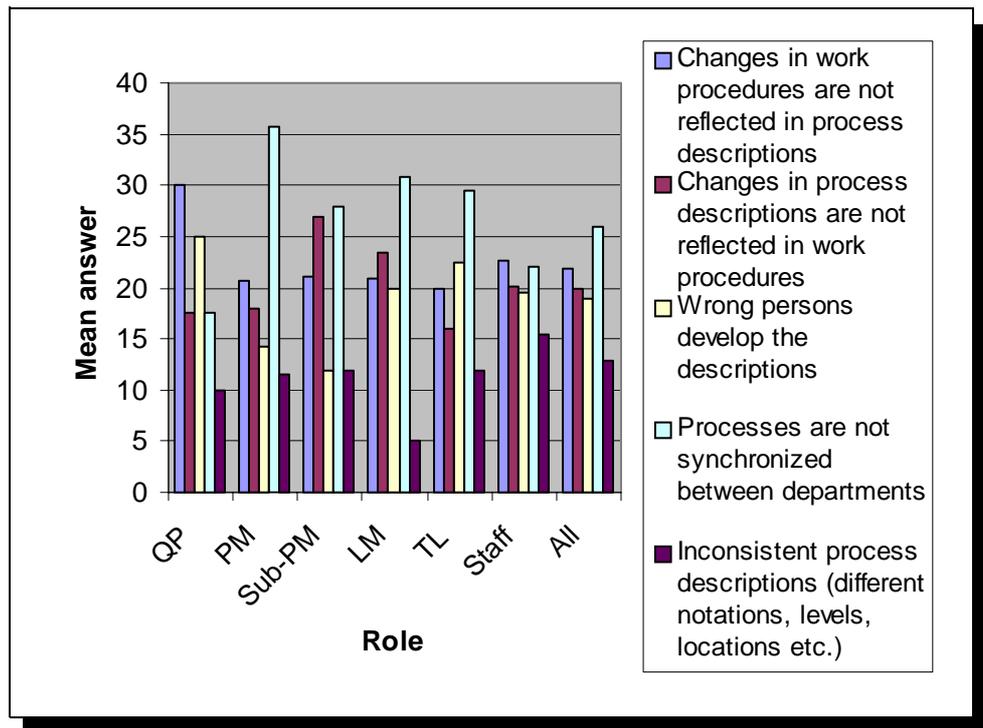


Figure A-21: 21. How is the relative urgency divided between the following 7 problems that must be resolved?

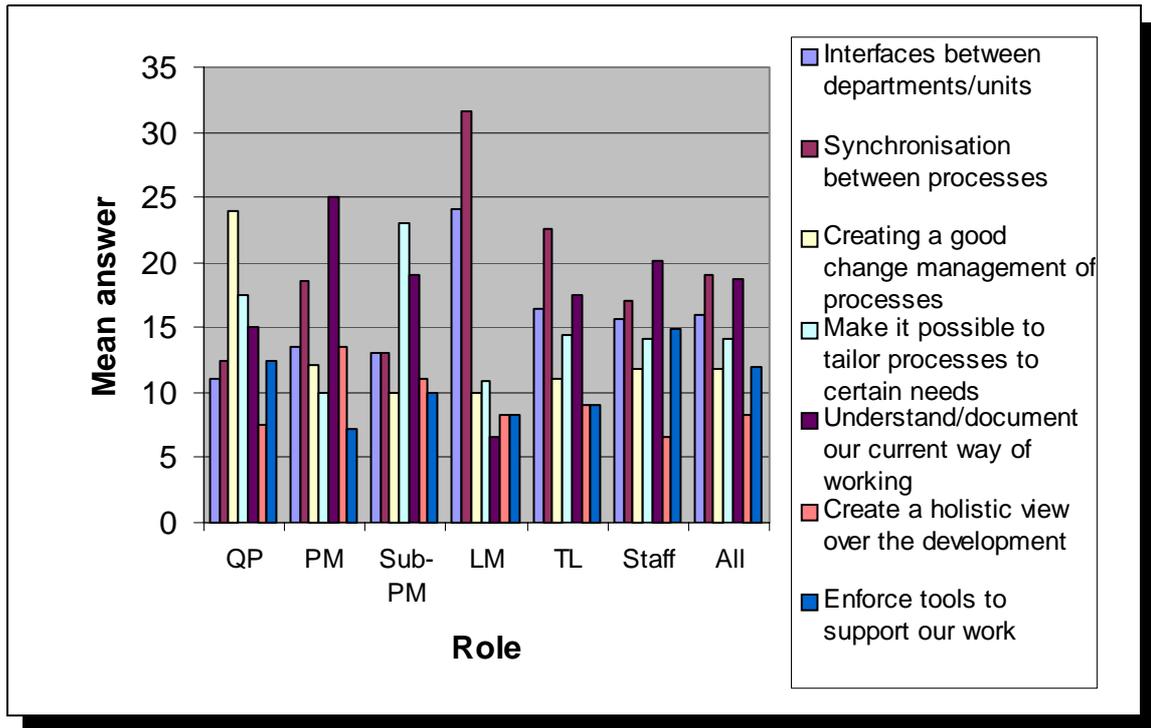
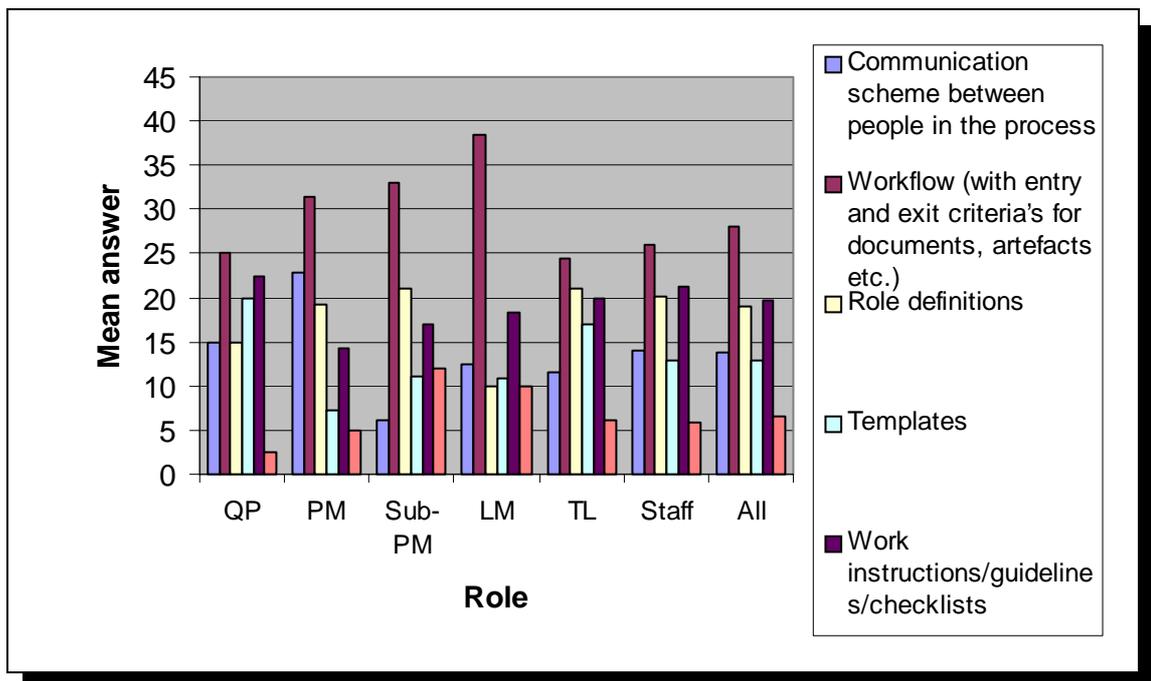
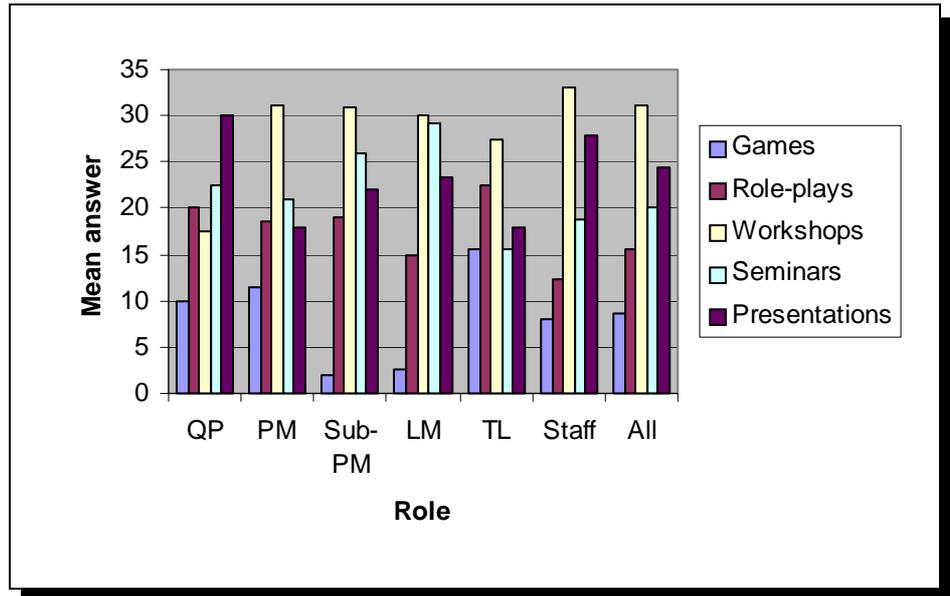


Figure A-22: 22. How is the relative importance divided between the following 6 factors regarding content of a work description/process?



FigureA-23: 23. How is the relative effectiveness divided between the following 5 ways to communicate/teach processes?



FigureA-24: 24. Gender?

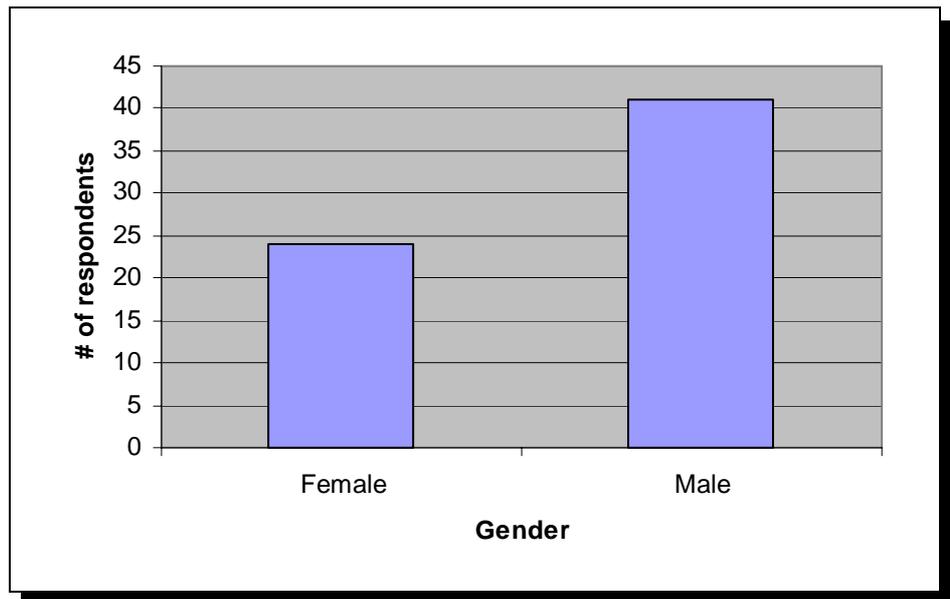


Figure A-25: 25. Year of birth? (in this graph divided into age groups)

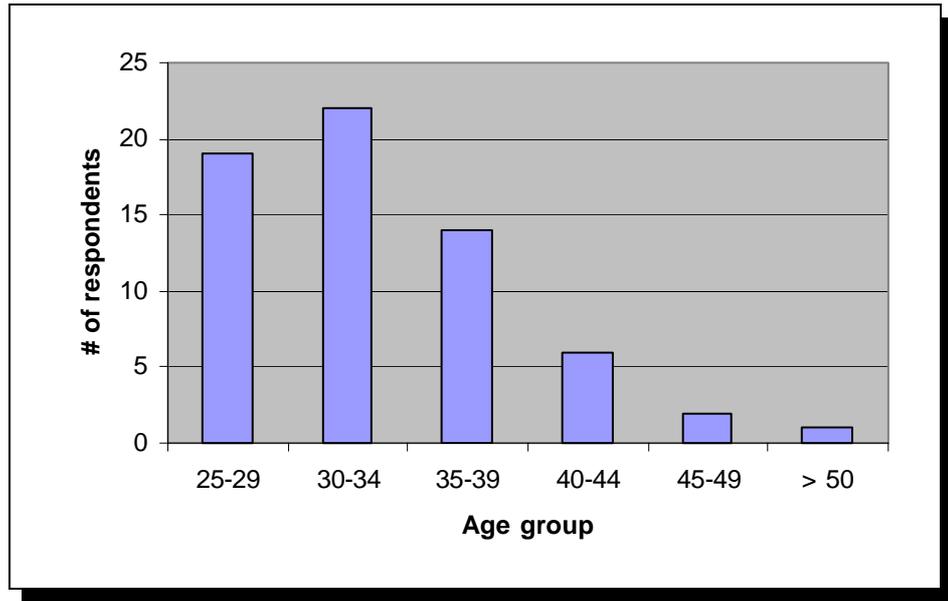


Figure A-26: 26. What is your primary function?

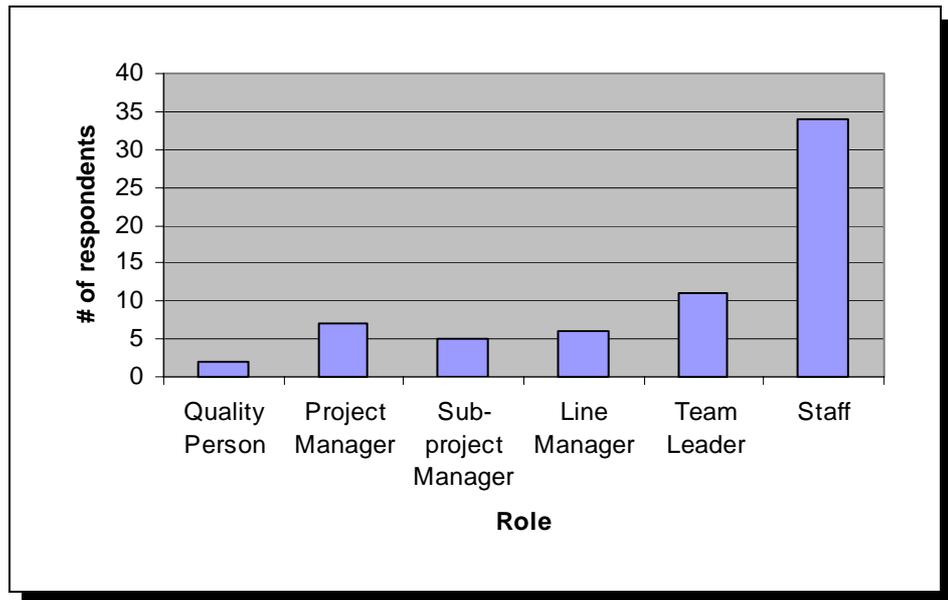
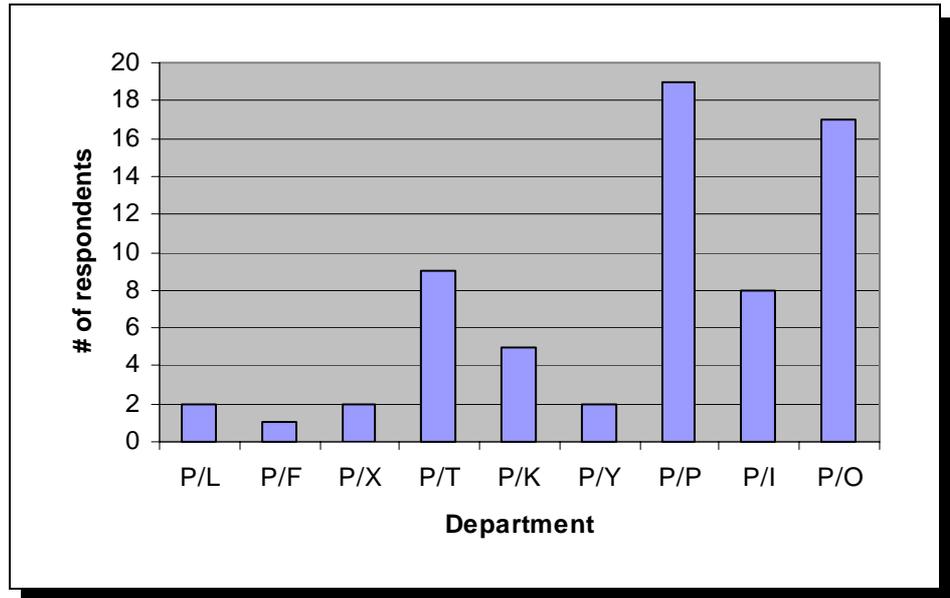


Figure A-27: 27. At which unit are you located (P/L, P/TI etc.)?



A.3 Remaning Questions

A.3.1 28. In which project are you currently primary involved? (PPS 3.4, PPS 3.6, line organisation etc.)?

The answers to this question were not used to produce a graph because of the answers differed a lot and several of the respondents stated that they were involved in a number of different projects. Hence, too many combinations of projects were received to present them in a graph in a way that would provide the reader with fruitful information. This data was not used in the analysis of the data either.

A.3.2 29. Do you have any further viewpoints regarding this survey or the subjects and questions it has handled, please write them below:

Fifteen of the respondents to the questionnaire chose to answer the open-ended question. Some of them have been included in the presentation of the result in section Section 7.2, but still some remains. Below, follow a summary of the thoughts and opinions these people had:

One respondent argued that PDU/PAY do not focus on the right things in process descriptions. He argued that the only thing that matters are the result they produce. It does not matter how fancy the processes are, if they cannot reach the market with the product as expected. Further, he stated that the processes should not focus on how to produce results, but what they shall produce. He also thought that today's descriptions are very seldom read because they are often too large and extensive.

Another respondent argued that new processes should be developed in project form in advance to their introduction in the projects. A way to reach larger openness to processes could be achieved through updating and improve existing ones and create new where missing. This together with people missions the processes and synchro-

nisation between processes would have increased this openness. He further argued that if PDU/PAY got a grip of the current status, it would have been easier to see potential improvements.

One respondent argued that when changing a process, it is not enough to just show how the process works. Effective process communication would have been created when showing what differences it has according to the old one. Processes are often very alike, and therefore the understanding would have increased if focusing on differences. He further argues that when a process shall be introduced, all documentation and such should be in place. Further, this information must be easy to find.

A respondent that has worked with a well working process argued that the most important thing is to clearly define entry and exit criteria that works across the line organisation.

One very interesting opinion came from another respondent. He stated that "as long as we have management that try to shortcut the processes as soon as something urgent happens, the processes will not be any better. It would have been nice to hear 'now it is urgent, now we really have to follow the process' from managers and steering committees".

Another respondent argued that a good process should be intuitive; you should not need to work with a process folder beside the keyboard. Tools used and how they fit together is the key to an intuitive process.

One respondent argued that processes are often seen as something that does not make the work easier, rather the opposite. He further argued that the most important thing is to feel that there is a simple support by the process, and when this support is needed, it is easy to find it. He further stated that if he should be honest, he does not know where to find processes today. He also believed that too much focus is put on producing documents to store the process in, rather than making usable processes. Further, when talking about tools, he stated that the most effective ones are they who are developed at a local level but realises that it is not effective when everybody have different tools. Global solutions do often work rather well at all places instead of really well in each place. Further, he argues that there are benefits with global solutions but often is it forgotten that these tools are not a very good support to the local process. He would like to see processes as a tool in the environment that is interactive. This would have made it possible to use process descriptions more than a paper product ever could do. Finally, he believed that processes have a lot in common with design, do it simple, do not attempt to do too general solution too early, understand what/how things work, and make it available.

Another respondent argued that this is a neglected area and it costs PDU/PAY a lot of time and resources.

The last respondent argued that the most important thing is to achieve goals and not strictly follow processes. The people who develop the processes must understand the work methods and the technology in order to develop processes that really are an aid in the work. Today, the people who develop the processes, do not have an understanding of how the people work in reality. This must be improved to be able to handle the processes in a better way.