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Reasons for Fire Fighting in Projects

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ABSTRACT

This work is a study examining the causes of fire fighting in software projects. Fire fighting is the practice of reactive management, i.e. focus being put at solving the problem of the moment. The study in the thesis is performed in two parts, one part is a literature study examining what academia considers as the reasons of fire fighting and how to minimise the problem. The other part of the thesis is an interview series performed in the industry with the purpose of finding what they consider the causes of the fire fighting phenomena. What is indicated by the interview series, as being the main causes of the problems are problems that are related to requirements, and problems caused by persons with key knowledge leaving the project.

Keywords: Fire fighting reasons, requirements management, key knowledge, software projects

CONTENTS

1 INTRODUCTION

The background of this master thesis project is an observation that today several software developing organisations are continuously facing unexpected problems, leading them to focus on the solution of the problem at the moment rather than the project as a whole. Often the quick and necessary solutions to the problems lead to new problems, and the situation escalates into a vicious circle of continuous problem solving. This behaviour of focusing on the problem at the moment trying to save the situation can be compared to that of extinguishing a fire, therefore the expression of fire fighting.

The consequences of fire fighting can be that budgets are exceeded, schedules broken, and many times the customers are unsatisfied. It is important that organisations know how to minimise the risk for fire fighting, therefore this thesis strives at finding the reasons for the problems and by that helping software developing organisations to decide where to start the work against the fire fighting phenomena.

This thesis establishes the fire fighting concept according to literature and presents some reasons for fire fighting. In order to establish how the fire fighting behaviour manifests itself, and what the causes are, a series of qualitative interviews are performed with people working in the software developing industry. The industry study is focused at establishing if there is a certain type of problem that occurs in the projects that are faced with fire fighting, and if all projects have some characteristic in common. It is mainly intended as an exploratory study, and will therefore only look at projects with problems. All conclusions should be studied further, examining projects of both success and failure. The intended audience of the thesis are software developing organisations that are facing problems with fire fighting.

The research questions that the thesis strives to answer are:

- What are the causes of the fire fighting phenomena?
- Can the fire fighting phenomena be traced back to a specific phase in the software process?
- What can organisations do to minimise the risk of fire fighting?
- Is the assumption that fire fighting lessens the productivity of the project, increase the lead-time and the cost of the project as well as lessen the quality of the finished product true?

The thesis is divided into seven different chapters besides this current chapter:

2. Process Maturity – This chapter introduces the concept of process maturity, and establishes the differences between a mature and immature software organisation according to literature. As a way of reaching maturity the Capability Maturity Model is introduced.

3. Fire Fighting – This chapter focuses on establishing the concept of fire fighting and its consequences, as presented by literature. Some common grounds for why projects experience fire fighting are presented, as well as some suggestions on how to avoid it.

4. Methodology - In this chapter, the difference between qualitative and quantitative studies is discussed and different approaches to interviews are presented. The structure of the questionnaire used in the interviews is presented, how it was tested, as well as the method for generalising the answers in order to find patterns. Finally, different aspects of validity of the study are discussed.

5. Results from the study - In this chapter, a short summary of each industry study participant's background is presented, as is the problems that were experienced by the participants in different projects, and some statistics about the projects.

6. Analysis of the study results - In this chapter different characteristics of the projects are discussed in comparison to the problem that occurred in the project leading to the fire fighting behaviour. The problems that are studied in this chapter are those related to requirements management and those connected to the loss of key knowledge. The projects in which these problems occurred are examined in the aspects of project size, project focus, schedule, development process, and tools that were used in the project.

7. Discussion and suggestions for further actions - In this chapter the answers found during the literature study and the interviews are discussed. Suggestions for possible further studies are also presented, since the study performed in this thesis is exploratory, findings can only be considered as indicators.

8. Summary - This chapter gives a summary of the thesis and what can be concluded from the study performed.

2 PROCESS MATURITY

This chapter aims at introducing the concepts of process and process maturity to the reader. The meaning of the word process in the sense of this thesis is established, as well as the need for an established process in an organisation. The immature and the mature organisation are discussed and the Capability Maturity Model is presented as a means of achieving a mature process. The main purpose of this chapter is to explore and understand the differences between immature and mature organisations.

2.1 What is a process?

Some definitions of the word process are presented in order to establish the word's meaning, as it is used in this thesis. There are two definitions that we found fitted the thesis and how we view the concept of process:

> "A sequence of steps performed for a given purpose, for example the software development process" [IEEE- STD-610]

> "A collection of activities that takes one or more kinds of input and creates an output that is of value for the customer." [Hammer and Champy 1993:35]

When using the word process in this thesis we use a combination of these two definitions: "A process is a set of activities that should be performed in a certain order so that they produce a result."

According to [Zahran 1998], there are three aspects of a process: the process definition, process learning, and process results.

- The process definition – the process is defined.
- Process learning – those that shall perform the process must know how to use it, therefore the second aspect is learning the process
- Process results – the results of the process is the third aspect, this is usually measured as the product resulting from performing the process.

All three aspects are important for a process to work in an organisation. It has to be defined so that those using the process know what they are supposed to do, and they also need to train and learn how to use the process guidelines. The result is important, because that is how the success of the process can be measured. The question we ask ourselves now is why does an organisation need a process? In the next section this question is explored further.

2.2 The need for an established process

In the previous section the word process was established. The need for an established process is discussed in this section through a comparison of the mature and the immature organisation.

In several software developing organisations there is today a problem of delivering quality software within budget and schedule, in spite of having tried new technologies and methodologies. The reason for these continuing problems is that the projects are chaotic and the organisations are lacking the ability to manage the software process. The attitude in the industry has been that many managers would rather want a faulty product on time than a perfect product late. The reasoning behind this attitude is that if they deliver on time, the schedule commitment has been fulfilled and the problems in the product can always be corrected later on. [Paulk et al. 1994]

Another problem that organisations are facing today is that programs being created are becoming more complex. More code is created and the programs get harder to test. Unless the error rate of the programs is decreased, those with high safety requirements can no longer be seen as reliable enough. If the organisation is mature enough to have collected historical data on testing and inspections, the cost of these activities can be reduced. The result of this would be that the organisation could afford more quality assurance of the product's safety. [Humphrey 1989]

The problems mentioned above are mainly being faced in an **immature** software developing organisation. The immature software developing organisation is characterized by that the participants in the project often improvise the software processes during its course, since there is no established process. If a process has been defined it is probably not followed. Management is being done reactionary and is mostly focused on solving the problem of the moment. Schedules and budgets are overrun more often than not, since the data they are based on are not realistic. When faced with hard deadlines, the immature organisation cut down on the quality and functionality of the system, since activities such as design, testing and reviews do not show progress in the same concrete way as coding. Quality of the product and the process cannot be measured and the members of the organisation have little understanding of how the process affects the finished product. [Paulk et al. 1994] [Zahran 1998] [Humphrey 1989]

The **mature** software organisation on the other hand, has communicated the process to all members of the staff and the process is consistent with the way the work actually gets done. The roles in the process and project are clear and followed throughout the organisation. In the mature organisation, management continuously monitors the quality of the product and the process, and judgements of quality as well as analyses of problems are made from an objective predefined basis. If changes to the process are necessary, these are first evaluated in pilot-tests or cost benefit analyses, before implemented. The whole organisation is actively involved in improvements of the process. Projects are usually on schedule and within budget, since estimates and schedules are based on historical data from previous projects. The mature organisation follows a disciplined process and all participants are aware of the value of doing so. There also exists an appropriate infrastructure that supports the process. [Paulk et al. 1994] [Zahran 1998]

According to [Zahran 1998] the benefits of using a common process over the organisation can be summarized as:

- Individual activities are aligned with the common goal of the group
- Contradictions between team activities are avoided, since there is a consistency across them
- There is a base for objectively measuring the individuals achievement in contributing to the process results
- The team can repeat earlier project successes, since there is minimal dependence on individuals.

There are several different methods developed in order to help organisations assess the maturity of their current software process and guide them to a more manageable one. Two methods are the ISO-standard and the Capability Maturity Model by the Software Engineering Institute (SEI). In the next chapter the Capability Maturity Model will be examined more closely.

2.3 Capability Maturity Model

Previously the need for an established organisation wide process was discussed and the immature organisation was presented in comparison to the mature. The advantages of a mature organisation seem obvious, but how to get there? In this section the Capability

Maturity Model (CMM) are presented as a model that can be used in order to achieve maturity.

The Software Engineering Institute has developed the Capability Maturity Model. The CMM is a framework that has five different maturity levels that a software development organisation shall work towards (see Figure 2.1 for the connection of the maturity levels). Each maturity level consists of a number of key process areas, which are made up by a cluster of activities. When these activities are performed together collectively they fulfil one key process area. In order for an organisation to be considered to have reached a certain maturity level, the key process areas defined for that level must be fulfilled. [Paulk et al. 2002] [Paulk et al. 1994]

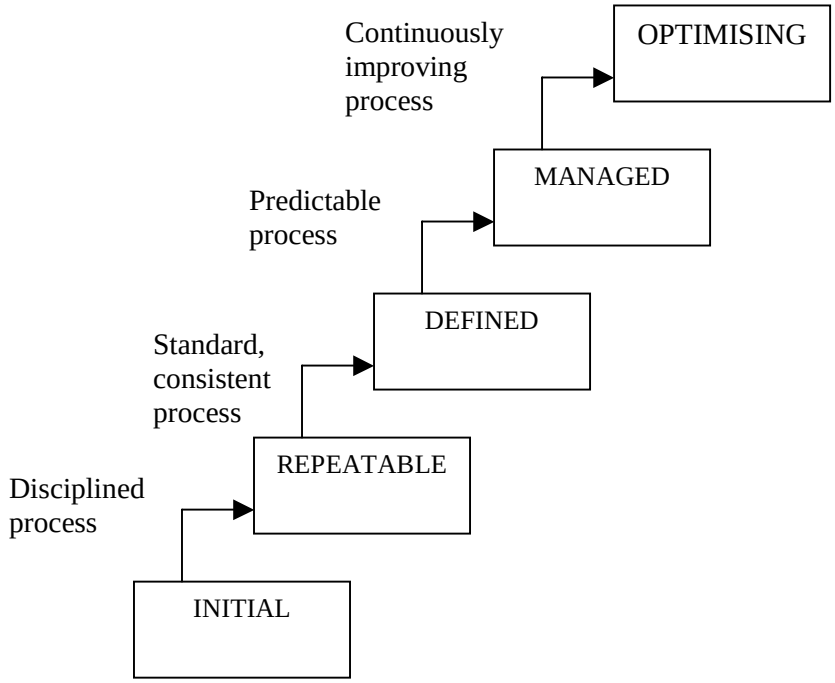

Figure 2.1. The five levels of software process maturity as described by [Paulk et al. 1994]

[Paulk et al. 1994] describes the five maturity levels as having the following attributes:
Level 1 - The Initial Level: The organisation does not provide a stable environment for projects to be performed in, instead the projects often create their own processes as they go along and are at many times chaotic. If a crisis ensues in the level 1 organisation, the project members focus on crisis management, and solving the problem of the moment. Projects that do succeed have often depended on a strong and experienced project manager that does not let the project take shortcuts in the process, however, when these experienced stabilizers leave the project, it often reverts back to old habits.

Level 2 – The Repeatable Level: The process used by projects shall be defined, documented, practiced, trained, measured, enforced and improvable. The process may differ between projects, but the organisation shall have set up policies and standards that guide the projects to an appropriate management process, and management are controlling so these are followed. Planning and management of projects are based on knowledge from similar projects, so the budgets and schedules are realistic. Costs, schedules, and functionality are controlled and any problems in meeting commitments are noticed when they arise.

Level 3 – The Defined Level: A standard process has been developed; it is documented and used by the whole organisation. Processes for both management and software engineering are included and connected into a whole. A group within the organisation has responsibility

of the process activities, and a training program has been set up in order to ensure that the staff can work according to the process and perform the tasks they are assigned. For each project the organisation wide process is tailored to suit its certain needs, so that the tasks in the project are performed in the best possible way. A well-defined process has readiness criteria, inputs, standards and procedures for how to perform work, verification mechanisms, outputs, and completion criteria. Since the process is well defined management has good insight in the project's progress. Both software engineering and management activities are stable and repeatable. Cost, schedule, and functionality are under control and the quality of the software is tracked.

Level 4 – The Managed Level: At level 4, the organisation has set up quantitative quality goals for software products and processes. All important software process activities in a project are measured for quality and productivity and the data is analysed and stored in an organisation wide database; this is part of the organisation's measurement program. The measurements are used to evaluate the processes and products in a project, with this knowledge a project achieves control over their products by discovering if the performance is falling outside the pre-defined boundaries of the project. The organisation is aware of the learning curve for a new application domain and takes this into consideration when predicting trends in process and product quality. The process is stable and measured, and therefore variations can be identified and addressed; when pre-defined limits are exceeded the organisation reacts and takes appropriate action.

Level 5 – The Optimising Level: Continuous process improvement is the focus of the entire organisation, weaknesses of the process are identified and improvements to strengthen the process are made proactively in order to prevent the occurrence of defects. Defects that do occur are analysed in order to find the cause, this data is then used for process evaluation in order to prevent the defects from reoccurring and lessons learned from projects are spread throughout the organisation. Cost/benefit analyses of new technologies and process improvement suggestions are made based on data on the software process effectiveness. The organisation is continuously striving towards improvement of process performance in the projects.

2.4 Summary

In this chapter the meaning of the word process has been established as "a set of activities that should be performed in a certain order so that they produce a result". A process has three aspects: the process definition, process learning, and process results.

Software developing organisations are facing the problems of delivering products on time and within schedule. One of the reasons for this is that systems are growing increasingly complex and therefore require more quality assurance activities than before. These problems are common in an immature organisation and are managed in a mature organisation. Some of the hallmarks of an immature organisation are that projects often run over schedule and budget, they resort to crisis management when facing an unplanned situation, and if a project succeeds it is often because of individual heroics.

A way for the immature organisation to work towards maturity is working by the Capability Maturity Model (CMM). CMM is a framework consisting of a number of key process areas, which are a number of activities that help the organisation towards maturity. The maturity of an organisation can be divided into five levels: initial, repeatable, defined, managed, and optimising.

3 FIRE FIGHTING

This chapter focuses on establishing the concept of fire fighting and its consequences. Some common grounds for why projects experience fire fighting are presented, as well as some suggestions on how to avoid it.

3.1 What is fire fighting?

Before we can discuss the causes and consequences of fire fighting behaviour, we need to establish what we mean with the expression. The literature presents different views on the meaning of fire fighting, so this section establishes what it means within the frames of this thesis.

[Paulk et al. 1994] describes fire fighting as the practice of reactive management; the management in an organisation is focused on solving immediate crises and in many cases do not use the process defined in the organisation.

[Hall 1998] suggests that fire fighting is crisis management, people in the project are too busy solving current problems and therefore do not have time to look at the future. This leads to further unexpected problems/crises, since no planning for future risks has been done.

According to [Repenning 2001] fire fighting is the allocation of scarce resources to solve unanticipated problems, mainly found late in the product's development cycle.

When discussing fire fighting in this thesis, we make a combination of the definitions of Paulk et al. and Hall. Fire fighting is the practice of reactive management, with the consequence that for each fire put out, a new one is most likely ignited.

3.2 Causes of unanticipated problems in projects

In the previous section, we established what we mean by fire fighting. Next, some possible causes of fire fighting found in literature are explored in order to create an understanding of why this phenomenon can occur.

Poor requirements analysis: A poor problem analysis has been performed and the requirements on the system are therefore not correct. This could happen for a number of reasons, but is often because of a misunderstanding between the customer and the project. Consequences of having the wrong requirements are that the schedule might slip, the customer might not be able to use the system and therefore the customer might choose not to use the company again, and maintenance costs of the system rises. [Sommerville and Kotonya 1998]

Unclear goals: If the goals are unclear the project does not know where it is heading, and tracking and control of progress becomes difficult, if not impossible. As a consequence of this potential problems cannot be discovered and planned for. [Hall 1998]

Poor planning: There is not enough information available for the project to do a proper work breakdown structure, and the lack of this leads to a poor schedule for the project. [Nicholas 2001] If this is not followed up, the project will most likely not be able to finish within schedule.

Knowledge of the staff: When planning the project, management must know about the potentials staff's experience, ability, skill, and training. [Pfleeger 2001] If managers do not have this knowledge about the staff, the wrong people might be given assignments and this will hold back the project.

Team structure: All individuals in the project are different and have their own skills and experience, however, if they cannot work together as a team, the progress of the project is likely to suffer and miscommunications are common. [Humphrey 1997]

Communication: It is important that the managers can communicate with each other and the team members in a clear way. The members of the team must know what they should contribute with for the project to be a success. [McManus and Wood-Harper 2003]

Commitment: The members of the project do not want to commit to the project, since they know the plan will not be kept, and therefore do not want to take responsibility for the tasks. The team members must make commitment freely; it cannot be forced on anyone. [Humphrey 1997]

Fire fighting on purpose: [Deming 1982] presents that one contributing reason to fire fighting can be that an individual who performs his/her work right the first time is invisible, since he/she only fulfilled the requirements. However, if the same employee was to first mess up and then correct it, he/she would be a hero. Another reason as for why the staff in the project would create the fire fighting situation is that many times they want to feel the excitement of having a tough schedule and therefore wait with doing important things until the last moment possible. [Cadle and Yeates 2001]

The process is not followed: When facing a problem, the project might avoid using the process because it forces them to make an uncomfortable decision. However, little literature addresses this problem. Hall gives a reason for this behaviour; the reaction management often has upon hearing of problems, is to shoot the messenger. This leads to project members not wanting to tell of a potential problem and follow the process guidelines for this. [Hall 1998]

Resource problems: [Repenning 2001] considers the hallmark of fire fighting to be the allocation of additional resources in the later stages of the project. This can lead to other projects loosing resources needed for activities that can prevent fire fighting in the early phases of the project [Repenning and Black 2001]. Another problem caused by adding resources late in the project is that the staff that are already part of the project have to stop doing progress driving activities in order to help the new members understand what to do. [Pfleeger 2001] If a person is taken from the project to work in another project or perhaps quit the organisation in all, this can lead to wonderings and uncertainty on who will be available to answer questions about that person's area. [McManus and Wood-Harper 2003]

Underlying conflicts: If there is a conflict between groups within the project this can lead to a lack of trust, respect, and cooperation. The groups can end up working against each other just out of spite, and putting up internal goals that might be working against the organisational goals. When emotions are controlling decisions the chance that a mistake will be done increases as the people involved in the project gets stressed about the situation. This situation contributes to breaking down communication in the project. [McManus and Wood-Harper 2003]

All of these reasons can cause problems for a project and if they happen to a project that is not aware of the potential problem, it can get serious consequences.

3.3 What are the consequences of fire fighting?

So what are the consequences of the fire fighting behaviour and why must actions be taken in order to prevent it from becoming de facto practice in the organisation?

Fire fighting costs an organisation time and money, since delivery dates often slip and thereby the chance of market success decreases. Managers and engineers often have to put in many extra hours, which cause stress and burnout, which in its turn can lead to the introduction of new errors. A common solution to the problem is that more people are added to the project, but this leads to new extra costs. [Repenning 2001] The reason for this extra cost is that the communication lines in the project increase, as well as the time that the additional staff needs to be trained in the project. [Brooks 1995] [Pfleeger 2001]

According to [Repenning 2001] managers often do not blame the process for the downward spiral, but blame the staff and thereby will not see the need for process improvement. The background for this is that once the project is faced with fire fighting, the staff will be spending time on activities that do not show progress. Management will most likely react to this is two ways. They might want to increase control over the process and start requiring more detailed reporting and adding more bureaucratic procedures to the process. If they do not do this, they might instead increase the demands on the development process with the goal of making the staff more efficient. Both of these solutions require that more people be added to the project in order to have time for the extra activities that management has added to the project. The management team gets frustrated over the staff that does not work as much or well as they should, and the staff feels that the managers do not understand the reality and have set unrealistic goals.

[Repenning 2001] means that fire fighting is usually something that shows up in the later phases of the project. It is many times in the test phase that fire fighting starts. The reason for this is that extra staff is usually put in to help with the testing or to solve the problems discovered in testing. This takes staff away from up-front activities in other projects, which are needed in order to prevent fire fighting in them. [Repenning and Black 2001] The consequence from this is as [Repenning 2001] present; that if one project in an organisation is facing fire fighting it is likely to spread to other projects.

All of these consequences can lead to project failure or customer loss, and it is important that an organisation take action on minimising fire fighting.

3.4 How can fire fighting be avoided?

The consequences and causes of fire fighting have been discussed, and some suggestions on how to get away from this behaviour are presented in this section.
First, risk management is discussed, since it allows the project to discover potential problems, and make action plans on how to move around the problem before it turns serious. Secondly, we look at postmortems and the gains from using them. By doing postmortems the organisation is working on spreading knowledge about previous projects, in order for other projects to make use of lessons learned, and avoid repeating the same mistakes.
Finally, some suggestions on how to use the established process in the project in order to avoid fire fighting are presented.

3.4.1 Risk Management

> "Risk management is the practice of assessing and controlling risk that affects the software project, process, or product" [Hall 1998:8]

There are five elements to the risk management process as described by [Hall 1998]:

- **Identify:** Identifying risks and their sources. It can be useful to not use the term risk, but instead talk about concerns, doubts, and uncertainties. Risks can be hard for the involved to identify, but if discussing obstacles towards reaching the goals of the project they are often easier to find.
- **Analyse:** Decide on probability and impact of the risk, and consider how the risk is affected by other risks and in its turn affect them.

- **Plan:** Plan for how to act in order to lessen the impact of the risk and evaluate different solutions. Make an action plan that states how to act with the risk and set up clear boundaries for when action should be taken.
- **Track:** Monitor the risk and the thresholds that were set up for the risk, establish triggers for when action must be taken in order for the risk to not become a serious problem.
- **Resolve:** Take action according to plan when trigger events occur, and decide when the risk is acceptable.

Identify and analyse are assessment practices, with the focus on finding the risk and evaluating it, while plan, track, and control are controlling practices that are aimed at managing the risk and the consequences of it. [Hall 1998]

[Hall 1998] also states that there are some basic concepts to risk management, which should be considered. These are goal, uncertainty, loss, time, and choice.

- **Goal:** It is recommended that the team has the goals and objectives clear to them when doing a risk analysis. If the goals are known risks can be assessed as to how they would affect these and what risks are acceptable.
- **Uncertainty:** There is always uncertainty involved in risk management, it is hard to see if a risk will occur or not. Priority of the risk is set according to the loss it would create and the probability that it will occur.
- **Loss:** A risk is always connected with a loss. It can be the loss in the sense of a bad outcome (loss of time or money, or even the contract), or a loss of an opportunity.
- **Time:** As there is less time left on the project the number of options on how to act on a risk often decreases.
- **Choice:** There is always a choice involved in risk management. The project can always choose between doing something to prevent the risk or doing nothing. However, this should always be a conscious decision.

Risk management helps the project avoid fire fighting in the sense that it makes the members aware of the potential problems, so they can work around it instead of going straight into it without a plan.

3.4.2 Postmortems

3.4.2.1 The purpose of postmortems

At the end of a project time should be set aside to do a postmortem. The focus of the postmortem is to analyse what worked well, and what did not work during the project. The goal is then to reuse and spread these experiences to other projects in order to avoid the same mistakes from reoccurring. [Cadle and Yeates 1997] [Jalote 2002]

Even if the experiences are too specific to be of use for others, those that did participate in the project gets the opportunity to reflect over what was done during the project, and what to think about when starting the next one. [Jalote 2002]

3.4.2.2 Benefits and uses of postmortems

A survey made on 92 organisations by Kumar [Kumar 1990], gives a number of benefits and uses of doing postmortems after a project has ended. The postmortems were used to:

- Verify that the installed system met system requirements
- Provide feedback to system development personnel
- Justify if the new system should be adopted, continued, or terminated.
- Clarify and prioritise further modifications of the system
- Transfer the responsibility of the system to the users.
- Report on system effectiveness to management
- Evaluate and refine system controls

- Provide feedback for modifications on development methods
- Verify the economic payoff of the system
- Close out the development project
- Provide feedback for modification of project management method
- Evaluate project personnel

3.4.2.3 A process for postmortems

Collier, DeMarco, and Fearey [Collieret al. 1996] suggest that postmortems should be done in accordance to a five-step process. The steps in this are survey, objective data, debriefing meeting, history day, and publishing the results.

1. **Survey:** A survey should be designed that can be used for any project in the organisation, since this enables the organisation to look for trends and similarities. It is important that the survey does not cover more areas than those actually of interest for evaluation, the questions should not be leading, and the answers shall be anonymous.
2. **Objective data:** After the results of the survey are in, objective data needs to be gathered as support of the opinions expressed in the survey. The recommended data to collect is that about cost, schedule and quality.
3. **Debriefing meeting:** A debriefing meeting with the team members should be held, where they may bring up and discuss things that did or did not work during the project. This meeting often brings up issues that have not been covered by the survey, and helps the leaders to analyse the root cause of the problems.
4. **History day:** Project leaders use the information gathered in the previous steps in order to set the problem statement that will be in focus during the history day. Key team players that have knowledge about the root causes to the problem are gathered; therefore all team members might not participate in this activity.
5. **Publishing the results:** After the history day, the knowledge gained about the problems must be spread in order for preventive actions to be taken. It is recommended that the letter containing this information shall have a project description, a list of positive findings, a summary of the three worst factors that led the project away from its goal, and finally a recommendation on what to do in order to improve.

3.4.2.4 Why postmortems might not help

Even if postmortems have been done, the information might not be used when starting a new project. [Statz 1999] identifies several reasons for this:

- If the information has been documented it is usually too much material to go through in order to find the parts that are important for the specific project.
- The organisation has not established a specific way for documenting the experiences from previous projects; so all projects organize the information in their own way.
- The reports on the problems are kept in locations, where only the team that experienced the problem can get to them.
- When needing information quickly, as is often the case when facing fire fighting, it is hard to find.
- There is time pressure on the projects to get started, so planning has to be done quickly and therefore there is no time available for studying previous experiences.
- The knowledge that is general from previous projects do not have enough supporting evidence to decide if it can be applied to the new project.
- The project is too distinct to use knowledge from others.

Distinctiveness is presented by [Milosevic 1997] as a common excuse for not using an organisation wide process in projects. It is expensive for an organisation to allow each project manager to create their own project specific process, and it also requires expertise and resources to create this. When lacking a process or the expertise to create one, management often ends up fighting fires. Since there is no real process, management

methods and metrics are chosen randomly, which leads to problems in reusing knowledge. [Milosevic 1997]

3.4.3 The established process

Since [Repenning 2001] considers the main problem of fire fighting to be the picking from scarce staff resources, he suggests that the solution for fire fighting is for the organisation to develop a resource planning system, which allows the manager to "visualize" the process state and simulate the outcome from various combinations of staff division. However, if the organisation does not have such a system, he suggests the following steps in order to avoid fire fighting:

- Avoid staff overloading, it not only add costs to the projects, but also changes the mode of process execution.
- Look at the current mode of the process when planning resources; do not plan resources as if the process was working. Instead, consider what the situation is now and if the process has changed during the project and plan for that.
- Track the need for resources as the scope and other problems cause the original requirements on the project to change.
- When the projects are missing their milestones/gates, do not let it pass with the assumption that it will catch up in the next phase of the project.
- When realizing that the process is not working, do not remove staff with the plan that the remaining staff will have to work according to the new, efficient process. When changing the process mid-project it often requires even more staff than before.

In order to prevent fire fighting, the organisation must resist focusing on specific projects and instead spend time on the integrity of the development process. [Repenning 2001] Humphrey supports this when talking about the use of the process in crisis: "After all, if the techniques and methods are appropriate, then they should be used in a crisis; if they are not appropriate in a crisis, they should not be used at all." [Humphrey 1989:7]

3.5 Summary

The concept of fire fighting, in the sense of this thesis is been defined as the practice of reactive management, with the consequence that for each fire put out, a new one is most likely ignited.

There are several underlying causes of fire fighting. Those identified are:

- Poor requirements analysis
- Unclear goals
- Poor planning
- Knowledge of the staff
- Team structure
- Communication
- Commitment
- Fire fighting on purpose
- The process is not followed
- Resource problems
- Underlying conflicts

Some of the consequences of fire fighting are that the organisation lessens the chance of market success and employees risk burnout. By moving staff between projects the organisation risks spreading the fire fighting behaviour, and management might start blaming the staff for the problems and thereby introduce more bureaucratic procedures.

Fire fighting can be minimised by doing risk management in order to plan for problems and work around them. Postmortems are also recommended as a method of spreading knowledge

of previous mistakes. The project should always be able to look at the process to know how to react in a crisis situation, since this should cover what to do.

4 METHODOLOGY

In this thesis a series of interviews will be performed in order to examine if the industry has experienced the causes of fire fighting as being the same ones as presented by literature in the previous chapter. The study will be qualitative, and is performed using the method of interviews. The purpose of the interviews is to find if there is a connection between the different aspects of a project and fire fighting behaviour.

In this chapter, the difference between qualitative and quantitative studies is discussed and different approaches to interviews are presented. The structure of the questionnaire used in the interviews is presented, how it was tested, as well as the method for generalising the answers in order to find patterns. Finally, different aspects of validity of the study are discussed.

4.1 Research types

[Holme and Solvang 1997] presents a couple of questions that should be answered when choosing between a qualitative and a quantitative study:

- Is the purpose of the study to get a total perspective of the unit studied, or is it to gain a complete understanding of it?
- Is the purpose of the study to create hypotheses and nuance interpretations, or is it to build up theories and create frames of reference?

In order to answer these questions, an understanding of the two types of studies is required.

4.1.1 Differences between the study types

Qualitative methods are used when the researcher wants in depth information about the unit being studied. It gives an overview of the whole phenomena being studied, which gives increased understanding of different processes and what connects them. Since the purpose is to gain in depth understanding, few units are studied in detail instead of many being studied on a high level. Qualitative studies are considered flexible, since they allow the research questions to be updated during the course of the study if it is necessary. The way the researcher approaches people who participate in the study can differ between persons in a qualitative study. Qualitative studies strive towards catching the distinctiveness within each of the units being studied, and the information that is gathered is therefore affected by the background and experience of the person. The risks with qualitative studies is that the information gathered might turn out to be useless, because the approach to the different study units have differed too much or the research questions have been changed during the study, and therefore the information gathered might not be comparable. [Holme and Solvang 1997] Common qualitative research methods are case studies, grounded theory studies, and ethnographic studies. [Robson 2002]

Quantitative methods are used when the researcher wants to gather information about a large group of study units. The purpose is not to gain an in depth understanding but to gain total knowledge of how several study units act in certain situations. Quantitative methods use a fixed design both in how it approaches the people participating in the study, and the formulation of the research questions. All people are to be addressed in the same way, and the questions cannot be updated, even if necessary. Questions asked have predefined answers that the person used in the study can select from. This requires that surveys and questionnaires be thoroughly tested before used for a quantitative study so that the answer suggestions are appropriate; pilot tests are a common method for this. Quantitative methods keep the distance between the researcher and the unit being studied, in order to not affect the outcome of the study. In these kinds of studies it is also important that the current situation the unit being studied is in, is not allowed to affect the results. The results are quantitative, which is easier to analyse than qualitative, since the answers are clear. [Holme and Solvang

1997] Common quantitative research methods are social surveys, experiments, official statistics, structured observations, and content analysis. [Silverman 2001]

After having discussed the two study types the questions posed in the beginning of the chapter can be answered. If the purpose of the study is to gain a complete understanding of the unit studied and creating hypotheses and nuance interpretations, a qualitative study should be chosen. If the purpose of the study if to get a total perspective of the unit studied and build up theories and create frames of reference, a quantitative study should be performed.

Both qualitative and quantitative studies are useful depending on what the purpose of the study is. A problem with qualitative studies though, is that the information gathered can be difficult to analyse, since it is often in flowing text form, therefore it often has to be quantified before it is analysed. [Holme and Solvang 1997] There are several ways for how to combine the two types of studies in order to create a more complete study

4.1.2 How to combine the study types

Quantitative and qualitative studies can be combined in different ways. [Holme and Solvang 1997] suggests the following three ways of combining the two types of studies.

- Quantitative studies can be used to show if it is worth to perform a more detailed qualitative study on a particular subject. It can also be done in the reverse way, qualitative data is used as a base for the study, and if something turns out to need more studying, a quantitative study can be used in order to see if the finding was a coincidence or of importance.
- Both types of studies can be used in parallel in a study to gather both more general data on several study units, and also gather more detailed information about specific things in the study.
- One combination of the two study types is that qualitative information is gathered and then quantified, before it is analysed. However, this method can be difficult, because a qualitative study seldom takes into account the structure and precision that is required by quantitative analysis techniques.

So far the differences between qualitative and quantitative studies have been discussed, but the methods for collecting the data in the study have only been mentioned briefly. One of these methods is interviewing.

4.1.3 Interviews

There are different types of interviews: fully structured interviews, semi-structured interviews, and unstructured interviews. [Robson 2002]

- **Fully structured** interviews have predefined questions and a predefined order in which they are dealt with.
- **Semi-structured interviews** have predefined questions, but unlike the fully structured interview, do not require that the questions be dealt with in any specific order. Wording can be changed if it suits the situation, and questions might be removed or added if it seems needed.
- **Unstructured interviews** have an agenda for the topic to be discussed, but let the discussion flow freely, without any predefined questions.

Questions used in an interview can be divided into three categories: open-ended, scale, and closed questions. [Robson 2002]

- **Open-ended questions** do not put any restrictions on the answer given by the interviewee, but allow them to formulate it as seems fit.
- **Scale questions** are often formulated as statements instead of questions, for which the interviewee is asked to put a degree of agreement or disagreement on.
- **Closed questions** have predefined answers from which the interviewee chooses.

According to [Robson 2002] open-ended questions have the following advantages over closed and scale questions.

- They are flexible.
- They allow the interviewer to clear up any misunderstandings and go more into depth on an area.
- They test the limits of the interviewee's knowledge.
- They encourage the co-operation of the interviewee.
- They allow the interviewer to make a more true assessment of the feelings and thoughts of the interviewee.
- They allow the interviewee to give unexpected answers, which can lead to an unexpected outcome.

However, a problem with open-ended questions is that if the interviewer is inexperienced, he/she might loose control over the interview.

When doing and interview it is important to consider whom to select for the interview so that the selection is valid. The selection shall be a conscious act, and not just a coincidence. [Holme and Solvang 1997]

For this thesis a set of semi-structured interviews with mostly open-ended questions is chosen as the research method, the reasons for this are explored further in the next section.

4.2 The Questionnaire

In this thesis a qualitative approach is taken to the study. The reason for this is that it allows the researcher more flexibility than a quantitative study would [Holme and Solvang 1997]. This is needed because the area is still unfamiliar in some aspects, since little information about the reasons and effects of fire fighting is found in the literature. Therefore, writing a survey with quantitative questions is not a possibility, and the researcher needs more freedom to ask follow up questions and clear out misunderstandings. A semi-structured interview with mostly open-ended questions is therefore used.

The questions in the questionnaire are divided in five different sections:

- **Those aimed at establishing the experience and interest of the interviewee.** This section of the questionnaire is used to establish the validity of the person being interviewed. It is also used in order to gain an understanding of how the background and experience of the interviewee might influence the opinions presented in the interview.
- **Those aimed at establishing if the interviewee has experienced fire fighting in any project.** If it turns out that the interviewee has no experience in fire fighting, the information will not help in finding out the causes of fire fighting. It might instead help finding how a project should work in order to avoid it.
- **Those aimed at finding out details about the problems that occurred during the project.** These are needed to create an understanding of why the problem occurred and the consequences from it.
- **Those aimed at finding the characteristics of the project.** These questions are used to establish if there is a connection between a certain kind of fire fighting problem and the basic prerequisites of the project. In order to understand why the problem occurred, it is necessary to understand the basics of the environment in which it occurred. In order to understand what should be done differently in the next project, it is necessary to understand what was done to solve the problem in this project.

The questionnaire is aimed mainly at project managers, since it is often they who have to face the consequences of fire fighting behaviour. Often, the project managers have worked as

some other role on the project before taking on the role as manager, and can therefore also contribute with experience from that role.

The interviewees are a mix of project managers from large international companies, and those that work in smaller national organisations. There is also a mix of consultancy firms and ordinary in-house developing organisations. The reason for this is that the aim of the study is not to examine the organisation itself, but the projects that an individual has participated in.

As a step in creating the questionnaire, two pilot tests were run to confirm the stability and essentiality of the questions.

4.3 Pilot tests

Before using the questionnaire in the interviews, pilot tests were run on two occasions. The goal of the pilot tests was to be able to make sure that the following questions had been answered after the interview, as well as making sure the interview would run smoothly.

- What was the cause of the problem?
- When was the problem discovered?
- What were the consequences of the problem?
- How was the problem solved?

The first test was done on an interviewee who has worked as a project manager in software projects for five years. All the evaluation questions had been answered after the interview, but some questions on the questionnaire were still changed, since they did not work smoothly. The beginning of the interview did not work well, since the focus of the questions was on problems experienced and not on a project that had been facing problems. This caused the interviews to focus on general problems, and the information that was to be gathered about the project was not possible to obtain.

After updating the questionnaire a second pilot test was run on another interviewee. This person has worked as a project manager for six years. The updates of the questionnaire worked; the interview ran smoothly, and the evaluation questions were still answered. Minor updates to the formulation of some questions were made after this interview.

The results from the two pilot tests are not used in the study, however they can be used as indicators if several project mangers bring up the same problems as they mentioned during the tests. After stabilising the questionnaire, which can be found in Appendix A – The Questionnaire, the method for analysis of the answers is created.

4.4 Method for analysis

After the interviews have been performed the answers are structured in order to simplify the analysis of the data gathered during the interviews. The answers are converted into predefined answers instead of the flowing text answers that are given during the interviews. The chart that the answers of each interview are transferred into can be found in Appendix B – Quantification of Results.

The goal of the analysis is to examine if there is a connection between the fire fighting behaviour and the characteristics of the project. It is also to see if the problem of fire fighting can be traced back to a certain phase in projects.

The characteristics that will be viewed and evaluated in order to find a pattern between the problems that occur and the projects are:

- The domain of the project.
- The size of the project.

- The focus of the project.
- The budget of the project.
- The schedule of the project.
- The technical complexity of the project.
- The customer's interest in the project.
- The target group of the project.
- The process that was used in the project.
- If the project was local or spread out on different places.
- If there were any tools to help prevent problems.
- If a root cause analysis was performed after the project was finished.

Since this thesis is an exploratory study, the results from the interviews will be studied and if the interviewees have agreed on different points, e.g. having experienced the same basic problem as the cause of fire fighting, this will be considered a finding for further studies. The validity of the findings will be considered according to reliability, internal validity, and external validity.

4.5 Validity of the study

In order for the study performed in this thesis to be considered trustworthy, certain things have been taken into consideration. These are reliability and internal and external validity. [Robson 2002]

When considering the reliability of a qualitative study, the researcher should consider if the tool or instrument used produces consistent results. This is a problem in interviews and case studies because a human being performs the study and can make mistakes [Robson 2002]. In order to minimise the risk of this in this thesis, a tape recorder is used during all the interviews, so that the researcher easily can return to what was actually said.

The internal validity factors that should be considered when performing a qualitative study are reactivity, respondent bias, and researcher bias. [Robson 2002]

- **Reactivity** is a threat to a study in the sense that the researcher's presence can affect the outcome. Since this thesis is based on projects that has already ended the study should not be threatened by reactivity.
- **Respondent bias** is when the researcher can be seen as a threat to the respondent or cause the respondent to try and give the answers that he/she thinks that the researcher wants. In this study, it should not be a problem since the results of the study are anonymous and the problems discussed are connected to a project instead of a person or organisation.
- **Researcher bias** refers to when the researcher affects the study by bringing his/her own assumptions or misconceptions into the study and because of that might pick a certain kind of group for the study. This can be a threat to the study in this thesis since the persons picked for the interviews are only from the group of project managers. However, since the project managers have different backgrounds before becoming project managers including other roles in projects, this threat should be minimised.

External validity refers to how the conclusions in the study can be generalised. If a certain group of people has been chosen for the study and some people has been excluded because they seem threatening or disturbing, the external validity is threatened [Robson 2002]. This can be a problem in this thesis in the sense that it is mainly only one group of people that are being interviewed, project managers. However, no one has been removed from the study because they could make it fail. The researcher has no personal interest in the outcome of this study, and has therefore no reason for excluding anybody. This also leads to that the objectivity of the study should not be a problem either. External validity also refers to how generalisable the conclusions made from the study can be considered to be, from the aspect

of who has been involved in the study. [Robson 2002] In this thesis the selection of study participants have been made from the population of project managers. The selection of participants covers both large and small software developing organisations, and consultant and in-house projects. The participants are chosen from the areas of telecommunication and software development. The projects that are studied vary between around 30 man-months to 550 man-months. The conclusions made from the study can therefore be considered as general for projects in these settings.

4.6 Summary

In this chapter the differences between qualitative and quantitative studies are discussed.

Qualitative studies	**Quantitative studies**
Is used to gain in depth knowledge about the area to be studied.	Is used to get an overview of a large group of study units.
Few units are studied.	Large amount of units are studied.
Flexible: allow for questions and approach to change during the course of the study.	Fixed: do not allow for changes in questions or approach.
The information gathered is affected by the background experience of the studied person.	The information gathered is not affected by the background or situation that the studied person is in.
The information gathered might turn out to be incomparable because the research question has changed during the study.	The information gathered might turn out to be useless because the research question has not been changed as more knowledge has been gained.

The two types of studies can be combined in three ways:

- One method is initially used to gather information before a larger study is performed in the other method.
- Both study types can be used in parallel to gather both qualitative and quantitative data.
- Qualitative information can be quantified and then a quantifiable approach to analysis can be taken.

There are three kinds of interviews: fully structured, semi-structured, and unstructured. When doing any of these three different types of questions can be used: open-ended, scale, and closed.

In this thesis semi-structured interviews with mostly open-ended questions are used. For the interviews a questionnaire divided into five sections of questions is used. The five sections of questions are:

- Those aimed at establishing the experience and interest of the interviewee.
- Those aimed at establishing if the interviewee has experienced fire fighting in any project.
- Those aimed at finding out details about the problems that occurred during the project.
- Those aimed at finding the characteristics of the project.

Before using the questionnaire in the interviews for the study, two pilot tests were done on persons in the target group. After the tests the questionnaire was updated.

After the interviews have been performed, the answers are quantified with the purpose of finding patterns between the fire fighting phenomena and the characteristics of the projects.

There are three things to consider about the study performed in this thesis; those are the internal and external validity of the study and the objectivity.

5 RESULTS FROM THE STUDY

In this chapter, a short summary of each study participant's background is presented, as is the problems that were experienced by the participants in different projects. Some statistics about the projects are also presented, however detailed information about the projects and the problems that were identified are found in Appendix C – The Results.

5.1 Interviewees

The information about the interviewees is divided into four sections for each person:

- Current position: what type of position the person has today.
- Company: what type of company the interviewee works at today. A company that has less than 50 employees will be considered as small, and one that has more than 250 employees will be considered as large. All companies that have between 50 and 250 employees are considered as medium sized. [Cordis 2003]
- Length of current position: how long the interviewee has worked in the current position.
- Previous position(s): what other roles the person has had when working in industry.

This information about the participants can be found in table 5.1.

All participants in the study have supplementary studies after high school. All except for Person C and Person I have a university education with varying degrees in computer science, software engineering, social science or teaching.

Eight of the interviewees are currently working as project managers and eleven out the twelve participants have at one time worked as a project manager. They have all worked in their current position for between six months and six years.

The interviewees are selected from eight different organisations and there are no more than two participants from the same organisation. If two participants come from the same organisation, the same project has not been discussed in the study.

Table 5.1, an overview of the background of the study participants.

Person	Current position	Company	Length of current position	Previous position(s)
A	System analyst with focus on requirements management.	Large, international telecommunications company.	Six months.	Project manager, designer, and unit manager.
B	Part-time project manager in pre-study and maintenance phases.	Medium-size, international telecommunications company.	Two years.	Integration and configuration manager.
C	Head project manager.	Large, international telecommunications company.	Three years.	Project manager for sub-projects, test manager, and tester.
D	Test manager.	Stately organisation.	One year.	Developer and consultant.
E	Project manager.	Large, international telecommunications company.	One year.	Project manager and teacher.
F	Region manager.	Consultancy firm in the Baltic region.	Two and a half years.	Tester, system development, and project management.
G	Consultant (as project manager, test manager, and course coach.)	Small, national consultancy firm.	Six years.	Application developer.
H	Senior project manager.	Consultancy firm in the Baltic region.	Three years.	Teacher and project manager.
I	Project manager.	Private, national consultancy firm.	One year.	Project manager and IT-consultant.
J	Project manager.	Small, national consultancy firm.	Two years.	Project manager, and account manager.
K	Software architect.	Small, national consultancy firm.	Two years.	System developer, software architect, and project manager.
L	Project manager.	Medium-size, international telecommuniations company.	Two years.	Developer and team leader.

5.2 Problems

The problems that were experienced by the study participants can be divided into the following seven categories:

- Requirements-related.
- Key knowledge disappears from the project.
- New things that have to be done in order to perform the project are discovered.
- A sub-contractor delivers a product with defects.
- Those involved in the project had different views on how the project should be performed.
- The organisation in which the project is to be performed is young and therefore processes used are untried.
- Communication problems.

Figure 5.1 shows the relation between the problems and the number of study participants that brought them up.

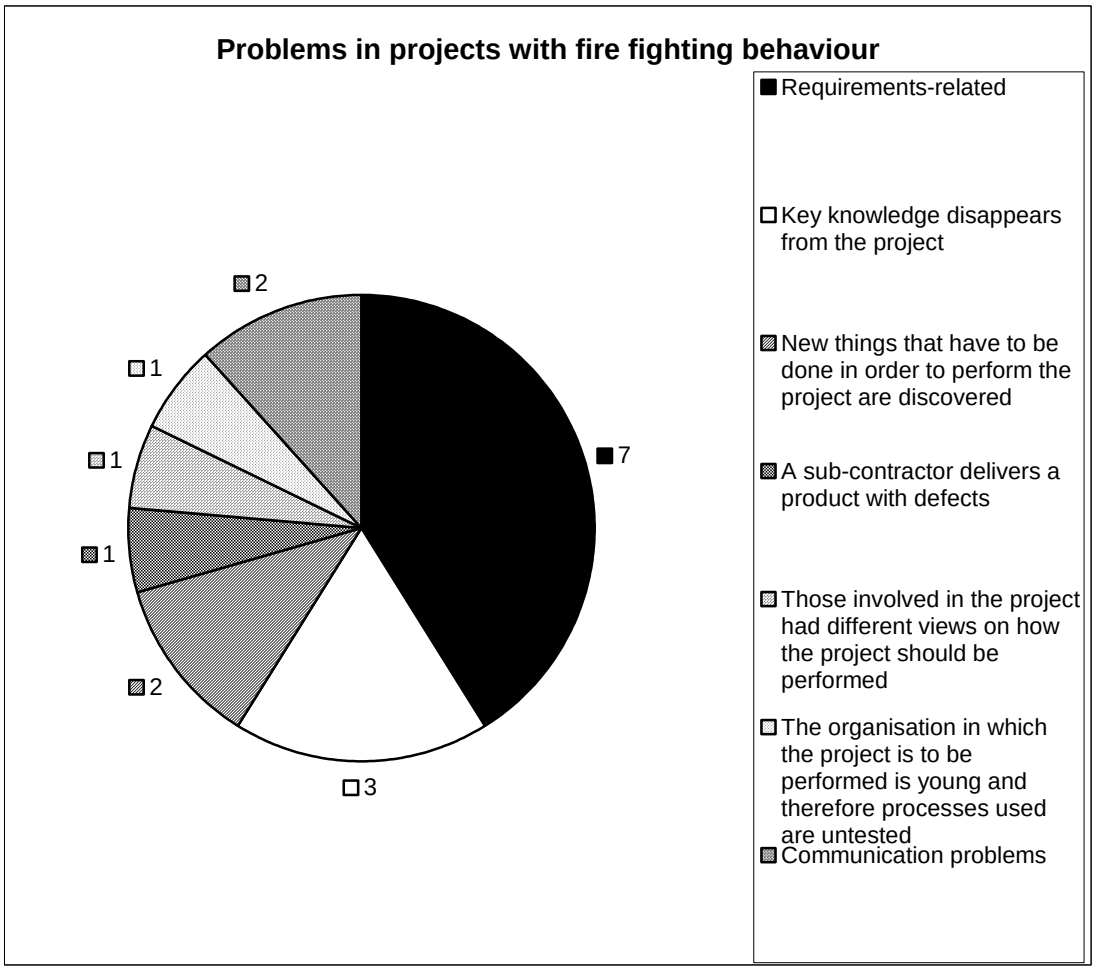

Figure 5.1, an overview of the problems presented by the study participants.

The problems were discovered in different phases of the projects. A project was divided into the following phases in this thesis:

- Pre-study
- Analysis
- Design
- Implementation
- Testing
- Delivery

Figure 5.2 shows how many projects discovered the problems in each of these phases.

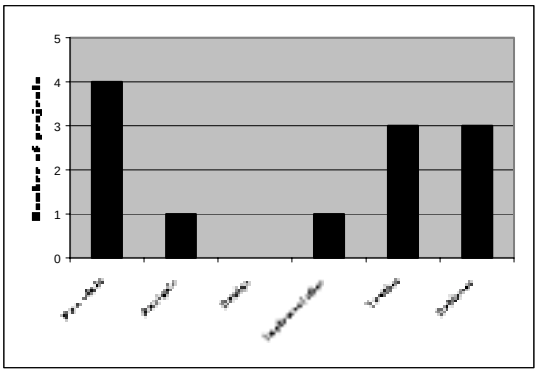

Figure 5.2, an overview of how many projects discovered the problems in each phase.

In the following sections in this chapter the problems are presented in more detail.

5.2.1 Requirements related

Seven of the interviewees brought up that they had had problems with requirements, some with the elicitation and some with the management of them. The study participants that did discuss this were: A, C, F, H, J, K, and L.

The problems that they experienced were that the requirements might not be properly handled when discovered. One project had no requirements management and therefore added new requirements as they turned up, with no thought at all about the consequences it would have for the rest of the system. Another project got requirements that had not been processed properly and therefore had to assume what the meaning and purpose of them were.

Several of the study participants highlighted that the problems with requirements often were based on the fact that the customer and the project members made assumptions. The project group thought that the customers knew more than they did, and the customers assumed that everything was clear and agreed upon. It was also said that if the domain was new, the elicitation of requirements was more difficult, since it was difficult to know what the system was intended to do.

5.2.2 Key knowledge disappearing

Three of the study participants presented the problem of key knowledge leaving in the middle of the project, the three interviewees were A, D, and G.

The problem manifested itself in that there was no documentation covering the knowledge that the participants had. Those left in the group spent time on reading up on the subject and discovered new things about the system to be developed, which had not been planned for. For one of the interviewees new requirements on the system turned up, which lead to problems with requirements, and new things that had to be done were discovered, which were not in the initial budget and schedule. For that project the loss of key personnel caused the problems with requirements.

5.2.3 New activities

As stated in the previous section, new things that had to be done were discovered partly because of new knowledge of the project was gained, but some study participants also mentioned the fact that an unknown domain could lead to this or just a poorly performed pre-study. Person B and D were the ones who brought up this problem

5.2.4 Sub-contractor

One interviewee discussed the problem of having an unreliable sub-contractor. The product received was not completely tested and therefore the whole product crashed when the

customer was testing the performance of the system. The study participant who brought this up was Person E.

5.2.5 Different views

One problem that had been experienced was that several consultancy firms being involved in the same project. Since they had different backgrounds, they also had different views on what the goal of the project was and which development process should be used. This was experienced by Person H, and had only been experienced to this degree when several consultancy firms were involved.

5.2.6 Young organisation and process

The problem with a young organisation is that it also has a young process and communication lines can be unclear. Person H discussed having participated in a project where it was unclear who was to do what and how things were to be done. Part of this problem was that the organisation was new and there were no established procedures for how things were to work.

5.2.7 Communication problems

Person D and I highlighted the problem of communication within the groups and towards the customers. The organisation and the customer having different cultures and therefore trouble in speaking in the same terms caused problems with communication. Another problem was reorganisations, which lead to it being hard to know who to talk to within the organisation when questions arose.

5.3 Statistics of the interview results

The data presented in this section is a summary of the interview results. When examining the data, the fact that the study is focused on projects faced with unexpected problems should be taken into consideration. The data examined are the project domains, project size, project focus, project constraints, development process, and the problems experienced.

5.3.1 Project domain

The domains of the projects examined were as follows:

- One project was in the domain of Internet communication. (Person I)
- Three were business related. (Persons D, J, and K)
- Seven were telecommunication projects. (Persons A, B, C, E, G, H, and L)
- One was a resource management project. (Person F)

As can be seen a majority of the projects used in the study examined are from the telecommunications domain.

5.3.2 Project size

When measuring the size of the project the measure of person months and project months were used. Project months equal the number of months in lead-time that the project lasted. Figure 5.3 shows an overview of the number of person months the projects took, and figure 5.4 shows the number of project months.

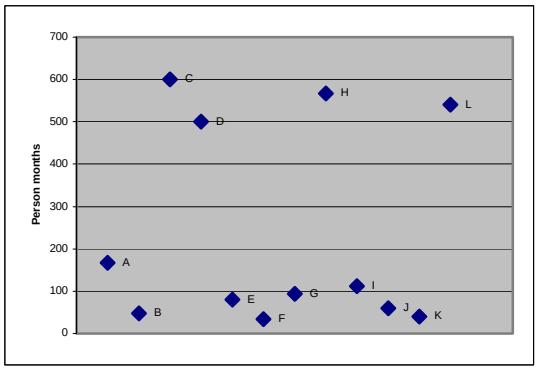

Figure 5.3, an overview of the number of person months that each project took.

No projects between 200 and 500 person months were unfortunately included in this study. As can be seen eight of the projects included are between 34 and 167 person months, and four are between 500 and 600 person months.

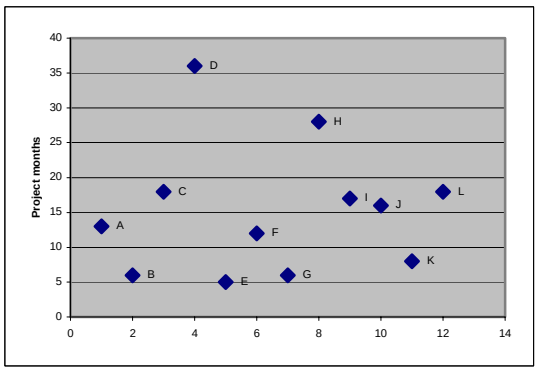

Figure 5.4 showing the number of months the project took to finish.

The distribution of project sizes concerning project months is a little more spread out than when considering person months. The distribution is between 5 and 36 project months, however only two projects lasted longer than 20 project months.

5.3.3 Quality or market?

The interviewees were asked to give their view on what had been the most important factor for the project when weighing between quality and time to market.

Of the twelve examined projects

- Four were focused on creating a high quality product
- Six were concerned with getting out on the market fast
- Two were focused of getting the product out on the market fast, but still had rather high requirements on product quality.

5.3.4 Project constraints

The projects were examined concerning their constraints as in budget, schedule, and technical complexity. Figure 5.5 gives an overview of how many projects that had a strict budget and broke it, and also how many projects had a strict deadline, and how many of these missed it.

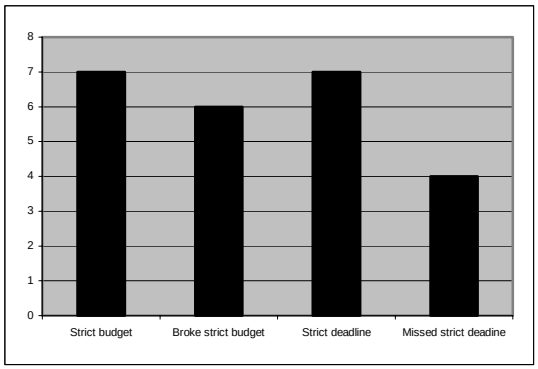

Figure 5.5, an overview of budget and schedule.

Of all the projects studied, ten broke the initial budget and seven missed the initial deadline. Eleven of the examined projects were considered as technically complex by the interviewees. Technical complexity could be anything from new technology to high security, reliability or performance requirements.

5.3.5 Development process

Nine of the organisations that the projects were performed in had established development processes. All of these were incremental methods; those that used project specific processes used a waterfall or evolutionary process.

Seven of the organisations in which the projects examined were performed were younger than ten years. Of these organisations that were younger than ten years, four has an established organisation wide development process.

It was only in the younger organisations that project specific development processes were used; all the older organisations used organisation wide processes that were adjusted to suit the needs of the project.

5.4 Summary

The problems that were experienced by the study participants can be divided into the following seven categories:

- Requirements-related.
- Key knowledge disappears from the project.
- New activities are discovered.
- A sub-contractor delivers a product with defects.
- Those involved in the project had different views on how the project should be performed.
- The organisation in which the project is to be performed is young and therefore processes used are untried.
- Communication problems.

The two most common problems were requirements related and key knowledge disappearing. Most of the problems were discovered in during pre-study, testing or delivery. A majority of the projects study were from the telecommunications domain, the others were business related, Internet communication, and resource management.

The project sizes vary between 34-167 person months and 500-600 person months, unfortunately there are no projects in between these to intervals included in the study.

6 ANALYSIS OF THE STUDY RESULTS

In this chapter an analysis of the problems experienced by the interviewees and the characteristics of the projects is presented. The problem areas that are discussed in this chapter are those that at least three of the study participants have brought up. The reason for why all problems will not be studied is that if only one or two participants have discussed them, then it is not viewed as a general finding, however it should be noted that some of them may become a general issue if the study is replicated or if it was possible to have more subjects. The two problems that have been discussed by more than two of the interviewees are those related to requirements and to the loss of key knowledge in the middle of the project; therefore those will be analysed in this chapter. The analysis of all characteristics compared to all problems can be found in Appendix D – Complete Analysis.

The following twelve characteristics of the projects studied have been analysed:

- The domain of the project.
- The size of the project.
- The focus of the project.
- The budget of the project.
- The schedule of the project.
- The technical complexity of the project.
- The customer's interest in the project.
- The target group of the project.
- The process that was used in the project.
- If the project was local or spread out on different places.
- If there were any tools to help prevent problems.
- If a root cause analysis was performed after the project was finished.

However, seven of these showed no significance for the study, in the sense that there was no significant majority in any direction, e.g. when studying the budget of a project compared to the projects. Seven projects experienced problems with requirements, out of these four had a strict budget and three had a loose budget. Of those three that suffered from key knowledge disappearing in the middle of the project two had a strict budget and one had a loose. None of this data shows any pattern between the characteristic and the problem.

The five characteristics to which a connection was indicated are:

- The focus of the project.
- The size of the project.
- The schedule of the project.
- The process that was used in the project.
- If there were any tools to help prevent problems.

Each of these characteristics will be discussed in the following five sub-chapters.

6.1 Project focus

The focus of the projects was divided into: getting the product out on the market quickly, having high quality, or having to achieve high quality with the pressure of reaching the market quickly. A distribution of all the projects' focus can be seen in figure 6.1 and how the focus of the project relates to the problems experienced can be found in figure 6.2.

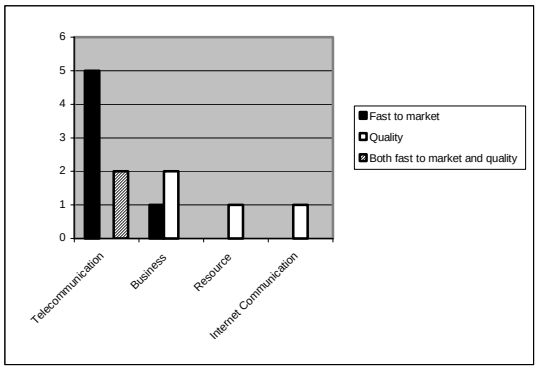

Figure 6.1, an overview of the focus of all the projects that participated in the study.

As can be seen in figure 6.1, all telecommunications projects were under pressure of reaching the market quickly, however two of them had to do it with high quality too.

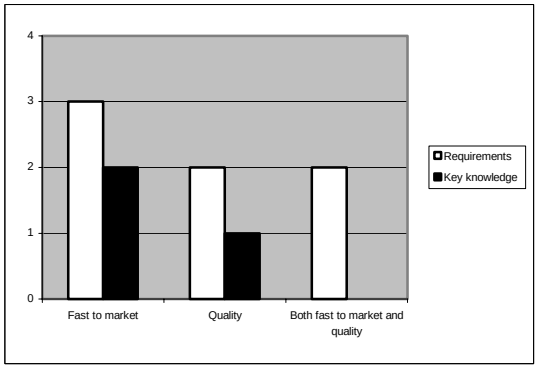

Figure 6.2, an overview of the division of project focus and problems.

Figure 6.2 shows that more than 70% of those having problems with requirements had high demands on when to reach the market. Out of the three projects that suffered from the problems with key knowledge leaving, two had demands on reaching the market quickly, and one quality demands.

6.2 Project size

When looking at the size of the project two different measurements have been considered: the lead-time, and the effort, both have been measured in months. Figure 6.3 shows the size in lead-time of the projects that have experienced problems with requirements compared to the size in lead-time of those that has not experienced these problems. Figure 6.4 gives an overview of the size in person months of the projects, and those that has had problems with requirements.

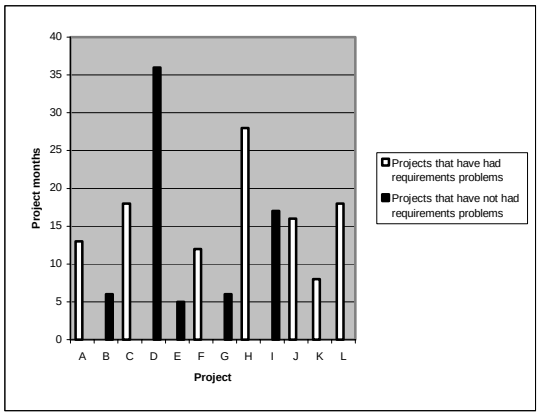

Figure 6.3, an overview of the lead-time of the projects and which has experienced requirements problems.

As can be seen in figure 6.3, the four telecommunications projects that had the longest lead-time were the four projects in that domain that suffered from requirements problems, i.e. A, C, H, and L.

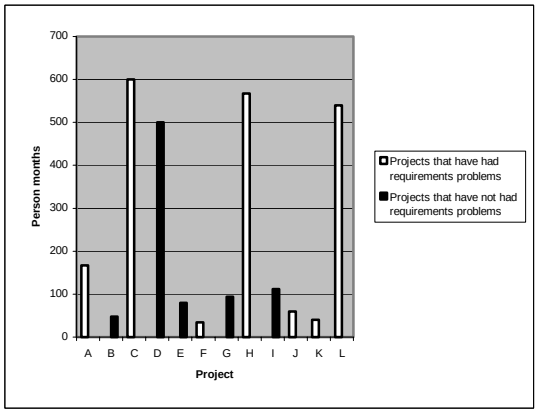

Figure 6.4, and overview of the person months of the projects and which projects that has experienced requirements problems.

In figure 6.4 it can be seen that both large and small projects have experienced problems with requirements, however it can be noted that the four largest projects that have experienced this are all telecommunications projects. It is also noteworthy that none of the smaller telecommunications projects have had these problems.

When considering the projects that have had problems with key knowledge disappearing there is a mixture of all different size of projects varying from 6 to 36 months in lead-time and 94 to 500 person months.

6.3 Schedule

When discussing the schedule of the project, the participants in the study evaluated if the deadline of the project had been one that had to be kept or if it could be postponed if necessary. Figure 6.5 shows the relationship between the domain of the project and the schedule, while figure 6.6 shows the relationship between the two types of problem and the schedule.

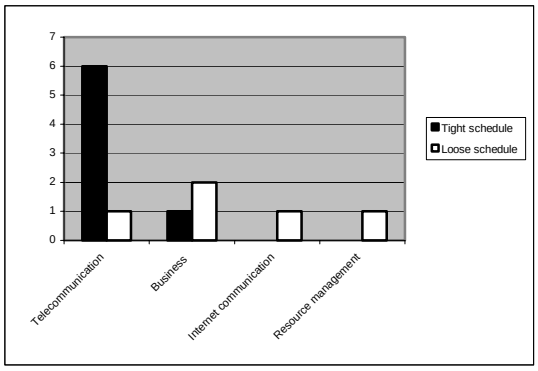

Figure 6.5, an overview of all the projects and how tight the schedule of the project was.

As can be seen in figure 6.5, approximately 85% of the telecommunication projects were on a tight schedule (six out of seven), as was also previously indicated in section 6.1 in this chapter.

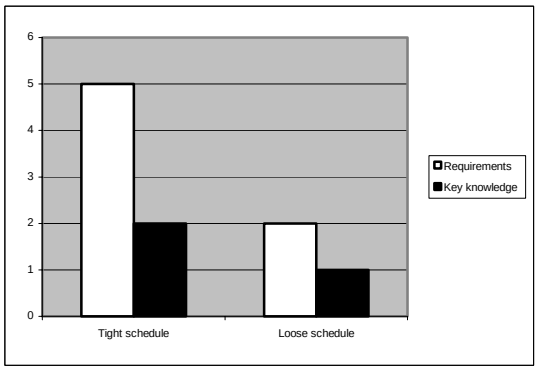

Figure 6.6, an overview of the projects that had problems with requirements and/or key knowledge and how the schedule was.

In figure 6.6 it is shown that more than 70% of the projects that had problems with requirements were on a tight schedule.

6.4 Project development process

The projects used either an organisation wide, established development process that was modified for the project's need, or a specific process, which was used for that specific project. Figure 6.7 shows which type of process the projects that had problems with requirements and key knowledge used.

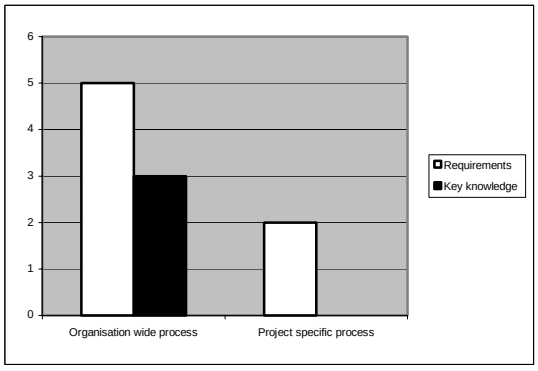

Figure 6.7, an overview of the type of process the projects that had problems with requirements and key knowledge used.

As it is shown in figure 6.7, most projects used an organisation wide development process. The two projects that did not do this used a waterfall and an evolutionary model respectively.

6.5 Tools

Preventive actions for fire fighting problems were in chapter 3 established as being risk management and postmortems. In the interviews the concept of contingency was added to these. Figure 6.8 shows how many of the projects that experienced requirements and key knowledge problems used tools like these.

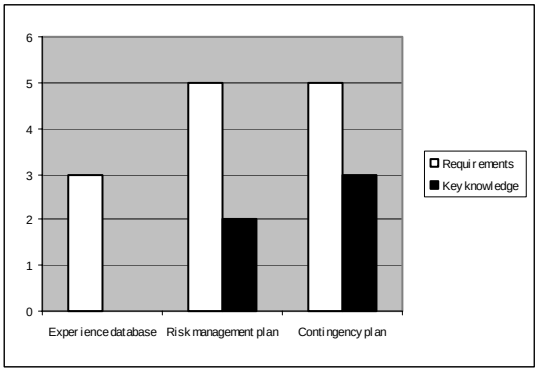

Figure 6.8, an overview of the tools used by the problem afflicted projects.

The three projects that had requirements problems and used an experience database were the only three in the whole study that had an experience database. However, as can be seen, a majority of those that had requirements problems had either a requirements management plan or a contingency plan or even both.

6.6 Summary

There were twelve characteristics of a project that was to be analysed compared to the problems experienced by the study participants. However, seven of these characteristics did not give any information of value, since there are too few interviewees. The characteristics that have been used in the analysis are:

- The size of the project.
- The focus of the project.
- The schedule of the project.
- The process that was used in the project.
- If there were any tools to help prevent problems.

The analysis shows that approximately 58,5% of the projects studied were having problems with requirements. More than 70% of those having problems with requirements had high demands on reaching the market quickly and thereby also had a tight schedule. The four largest telecommunications projects both in person months and lead-time have had problems with requirements. More than 70% of the projects with requirements problems used an established organisation wide development process. Five of the seven projects having problems with requirements had a risk management plan and/or contingency plan.

7 DISCUSSION AND SUGGESTIONS FOR FURTHER ACTIONS

In Chapter 1 – Introduction, the research questions for this thesis were presented as:

- What are the causes of the fire fighting phenomena?
- Can the fire fighting phenomena be traced back to a specific phase in the software process?
- What can organisations do to minimise the risk of fire fighting?
- Is the assumption that fire fighting lessens the productivity of the project, increase the lead-time and the cost of the project as well as lessen the quality of the finished product true?

In this chapter the answers found through the literature study and the interviews are discussed. Suggestions for possible further studies are also presented, since the study performed in this thesis is exploratory, findings can only be considered as indicators.

7.1 The problems

As presented earlier in chapters 5 and 6, the problems that have been discussed during the interviews are:

- Requirements-related.
- Key knowledge disappears from the project.
- New things that have to be done in order to perform the project are discovered.
- A sub-contractor delivers a product with defects.
- Those involved in the project had different views on how the project should be performed.
- The organisation in which the project is to be performed is young and therefore processes used are untried.
- Communication problems.

All of the problems that were found in the study, except for that concerning the sub-contractor, are found in the literature that was studied for this thesis. The problems that the literature brings up are presented in section 3.2. In this chapter, just as in the previous chapter, only the problems that are related to requirements and disappearing key knowledge are addressed, since the other problems that were brought up by the interviewees were only discussed by one or two persons, which is too few to give any indications.

7.1.1 Requirements

The basis for the requirements problems according to the literature is mainly that the analysis is done poorly or the customer and project misunderstand each other. The interviewees also bring this up, however they also emphasize the problem of requirements management. Once new requirements were discovered they were not managed correctly, i.e. evaluated if possible, dependencies on other requirements were not considered etc. Consequences of these problems are described by [Sommerville and Kotonya 1998] as the system being delivered late, unreliable and not meeting up to customer expectations.

7.1.1.1 Process improvement

A way to start the process of improving this area would be for the organisation to spend time on developing a stable requirements management process. Nine of the twelve projects studied used an organisation wide development process, which might be expected to contain a stable process for requirements management. However these processes are not always mature enough, but still under development or might not even contain guidelines for the requirements process.

7.1.1.2 Schedule and budget

Another thing to consider is that five of the seven projects that experienced problems with requirements were on a strict schedule. This might have caused the project teams to loosen up the process of requirements change thinking that it would take too much time to have a formal process, leading to new requirements being added to the project without proper evaluation. [Sommerville and Kotonya 1998] however states that it is many times cheaper to correct an error found in the requirements phase than in later development phases.

Problems caused by requirements being discovered late in the development process can cause both the budget and deadline to break [Sommerville and Kotonya 1998]. This seems to have been the case also with the projects that have been studied in the interviews; of those seven having had requirements problems only one did not exceed the budget or the schedule. However, this study has not examined the external factors that could affect schedule and budget, such as market conditions or the stability of the organisation.

7.1.1.3 Project size

What has been noted during the study is that the four telecommunications projects that had problems with requirements were the four largest of the telecommunications projects, when measuring size in both person months and project months.

When looking at the measure of person months, could this be the cause of the problems? It is rather likely that it is part of the problem, since each person that is added to a project increases the communication lines [Pfleeger 2001], and all changes to requirements have to be synchronised with the different sub-groups within the project. If a stable requirements change process does not exist in the project the difficulty of communicating requirements changes to all involved increases. However, in order to verify this a more detailed study should be done looking at more projects in various sizes, since this study does not have any projects between 167 and 500 person months. Projects with established working requirements processes should also be studied compared to projects with lacking processes to see if any finding is unique for the projects with problems.

When considering the measure of lead-time two different explanations of events have to be considered. One explanation could be that the project has a long lead-time because the requirements keep changing. However it could be the other way around, the requirements keep changing because the project takes so long to finish and new knowledge is gained as the project goes along. The study performed in this thesis indicates that there is a connection between the problem of requirements and the lead-time of a project. It does not show which factor it is that is affecting the other, to know this further studies should be performed on projects of various sizes in order to verify that the connection between the problem and lead-time is real. This is indicated to mainly concern the telecommunications projects, since the three large projects that had problems with requirements were from the telecommunications domain, however this could be caused by the lack of data from other domains, therefore projects from all domains should be examined.

When looking at the size of the project and the problem with requirements, further studies should also include successful [1]projects, since this study only gives an image of those suffering from problems and therefore not a true picture of the software development world as a whole. There is the possibility that a study considering successful as well as problematic projects, will show that there is no connection between person time/lead-time and the requirements problem, since a large majority of the projects are successes. It is also important that a continued study examines projects of different domains in order to see if the findings concerning size are unique for the telecommunications domain, or if it applies to all software development projects.

[1] Successful implies projects that were not faced with continuous problems.

7.1.2 Key knowledge disappearing

[McManus and Wood-Harper 2003] touches on the problem of loosing key knowledge in a project when they discuss the problem of a key person disappearing from the project leaving those remaining in the team wondering about whom to ask about that person's specific knowledge.

The problem experienced by some of the study participants though seems, to be that the person not only left, but also left without leaving documentation of the work performed, leading those left in the project to redo the work or put effort into understanding the conducted work in detail. A possible solution for those organisations would be to work on the development process and which documentation that should be created during the project. All three projects that faced this problem used an organisation wide, established development process. So the question is if the process was not followed, or just did not specify what to create in sufficient detail, since the problem occurred. This study does not cover this aspect and it should be looked into in more detail to see if there is a connection between the development process used and the problem of handling the loss of a key person.

In the previous chapter the aspects of focus, schedule, and size were addressed when looking at the problem of loosing key knowledge. None of these showed any strong correlation to the problems, since there was no factor where all three projects were in an agreement. For example, two projects had the focus of reaching the market fast and one had the focus of the product having high quality. This type of relation falls on all three of these factors and can therefore not give any concrete information. A new study ought to be performed looking at several projects that have experienced the problem of loosing personnel with key knowledge, as well as looking at successful projects in order to examine if anything found is unique for projects that are faced with problems.

7.2 The tools

In section 3.4 different methods for minimizing the effects of fire fighting were discussed. These methods were risk management and postmortems. [Repenning 2001] also gave some general hints on what to do in order to avoid fire fighting.

7.2.1 Risk management

Eight of the projects that were examined had a risk management plan when starting the project and in three of the cases the problems that later occurred were discovered in the plan, but nothing was done until the problem was a fact. Comments from the interviewees showed that the risk analysis often focused on problems on other levels than those that actually occurred. For example the risk analysis brought up that there could be a problem in a module, however it did not bring up that there might be a problem with a requirement that the project did not know enough about. In some cases the risk analysis touched upon the problem, but did not cover it to the extent in which it later occurred.

7.2.2 Postmortems

Six of the projects studied did a root cause analysis after the project, and four participants interviewed about those projects stated that the knowledge had been spread within the organisation. However, only three of the interviewees said that they had access to some form of experience database containing knowledge about previous projects and one of them did not do a root cause analysis. All interviewees said that they had experienced the problems in other projects as well as the one that was examined for this study. What should be looked at more closely is why knowledge about a problem is not transferred to other projects.

7.3 Capability Maturity Model

When an organisation is at CMM level 2 it should have a repeatable and stable requirements management process [Paulk et. al 1994]. This could imply that the seven projects that had problems with requirements were still on CMM level 1, however the study unfortunately does not examine the maturity level of the organisation on the scale that the Capability Maturity Model. The reason for this is that several of the organisations do not use CMM for process improvement, which means that the answer on which level the organisation is would be subjective for the interviewee. It recommended that a new study be performed looking at projects that has experienced these problems and examines the maturity of the organisations.

CMM does not give support for knowledge preservation in the organisation. It says that the organisation should train the people in the organsiation and that the projects should be planned according to the knowledge of the project members [Paulk et al. 1994]. The support that the CMM does give to handle the loss of key personnel is that everything should be documented and built on the process, instead of on individuals, which would lead to the loss of personnel not being as severe.

7.4 Recommendations for further studies

When looking at the results from this study it is important to keep in mind that all the projects that are studied are problematic projects. This means that any patterns discovered can only be considered as indications and not facts. In order to draw any conclusions about these patterns more projects have to be studied, both successful and those that have faced problems. If only those that have had problems are studied nothing can actually be concluded because there is no way to tell if a finding is unique for problematic projects or if it actually applies to all projects, problems or no problems. This study can therefore only be viewed as an exploratory study giving an overview of what the main problems behind fire fighting in projects are. These are according to the findings of this study, problems with requirements elicitation and management, and keeping knowledge within the project/organisation and not person bound. The pilot interviews that were done in order to test the questionnaire also indicated that problems with requirements were the main cause of the fire fighting behaviour.

Many of the projects did root cause analysis of the problems that occurred, however the study indicated that few of the projects had access to other postmortems and root cause analyses. This thesis does not explore the solutions to the specific problems. A further study could examine which information is gathered during root cause analysis and postmortems, and how this conforms to the information needed to avoid the problem in a later project.

7.5 Conclusions

The results from this study indicates that in order for organisations to avoid fire fighting they should spend time on requirements management and be aware of the fact that new requirements turn up as the project proceeds, and therefore develop a stable requirements management process. Organisations should also consider processes to keep the knowledge of the staff in the organisation and not just in the person.

7.5.1 The research questions

The research questions that were posed in the beginning of this thesis are:

- What are the causes of the fire fighting phenomena?
- Can the fire fighting phenomena be traced back to a specific phase in the software process?
- What can organisations do to minimise the risk of fire fighting?
- Is the assumption that fire fighting lessens the productivity of the project, increase the lead-time and the cost of the project as well as lessen the quality of the finished product true?

After having performed the study the following answers to the research questions have been found.

- The causes of the fire fighting phenomena are indicated as being mainly lacking a functioning requirements management process, and how to keep knowledge preserved in an organisation.
- Most of the problems were discovered in the pre-study phase or during testing or delivery, however the study does not show any certain phase in which the problems were introduced. The requirements process is a continuous process that lasts all through the project. The problem of loosing key personnel cannot be said to happen in any certain phase of a project, however the seriousness increases as the project proceeds.
- In order to minimise the risk of fire fighting organisations should put effort into developing a proper requirements management process in order to handle requirements in a controlled manner as they turn up. Organisations should also try to examine different methods for preserving knowledge in an organisation and not just in a single individual. So if a person leave in the middle of a project, the knowledge does not leave with him/her.
- Seven of the projects examined for this study missed the initial deadline; this indicates that the lead-time of the projects increases with fire fighting behaviour. Ten of the projects broke the initial budget, which indicates that the cost of the project increases when faced with fire fighting. Five of the customers were not satisfied with the end product that was delivered, however seven were satisfied, which implies that the quality of the product probably was still acceptable. All of these figures only give indications that the lead-time and budget increase, and the quality decreases when a project faces fire fighting. In order to know if this really is because of the fire fighting, a larger study should be performed containing both successful and problematic projects. The focus of the study should be on finding out if these three factors are affected by the fire fighting behaviour or if some other events in the projects are the cause of the delays and costs.

7.6 Summary

The study that has been performed in this thesis is an exploratory study mainly aimed at capturing the cause of fire fighting behaviour in projects. The two problems that were found as being the main causes of fire fighting were problems with requirements and the management of them and the loss of key personnel in the middle of the project.

There is an indication that the problems with requirements are related to the size of the project, both when measured in lead-time and in person months. It is also indicated that if the project is facing problems with requirements the schedule and/or budget are at risk of being exceeded.

There is no indication of a connection between any of the factors that were analysed and the problem of key knowledge leaving the project.

A majority of the projects studied had a risk management plan however these often did not cover the type of problems that later occurred in the projects, which left an opening for these problems. Several of the projects did postmortems, but they had not had old postmortems available when planning the current project, this indicates that the spreading of knowledge about previous problems was lacking.

In order to minimise the risk of fire fighting in projects, organisations should put focus on a well functioning requirements management process, and the preservation of key knowledge.

All of the results from this study should be further examined, by looking at both successful and problematic projects. The reason for this is that looking at only problematic projects does not show if the problems are unique for fire fighting projects, or if it is common for all projects.

8 SUMMARY

In this chapter a short summary of all the chapters in the thesis is presented.

8.1 Literature study

Software developing organisations are facing the problems of delivering products on time and within schedule. One of the reasons for this is that systems are growing increasingly complex and therefore require more quality assurance activities than before. These problems are common in an immature organisation and are managed in a mature organisation. Some of the hallmarks of an immature organisation are that projects often run over schedule and budget, they resort to crisis management when facing an unplanned situation, and if a project succeeds it is often because of individual heroes.

A way for the immature organisation to work towards maturity is working by the Capability Maturity Model (CMM). CMM is a framework consisting of a number of key process areas, which are a number of activities that help the organisation towards maturity. The maturity of an organisation can be divided into five levels: initial, repeatable, defined, managed, and optimising.

The concept of fire fighting, in the sense of this thesis is defined as the practice of reactive management, with the consequence that for each fire put out, a new one is most likely ignited.

There are several underlying causes of fire fighting. Those identified are:

- Poor requirements analysis
- Unclear goals
- Poor planning
- Knowledge of the staff
- Team structure
- Communication
- Commitment
- Fire fighting on purpose
- The process is not followed
- Resource problems
- Underlying conflicts

Some of the consequences of fire fighting are that the organisation lessens the chance of market success and employees risk burnout. By moving staff between projects the organisation risks spreading the fire fighting behaviour, and management might start blaming the staff for the problems and thereby introduce more bureaucratic procedures.

Fire fighting can be minimised by doing risk management in order to plan for problems and work around them. Postmortems are also recommended as a method of spreading knowledge of previous mistakes. The project should always be able to look at the process to know how to react in a crisis situation, since this should cover what to do.

8.2 Study

A series of interviews is performed in this thesis, with the purpose of establishing what industry considers to be the reasons behind the fire fighting problems in projects. A questionnaire was created and tested in two different pilot interviews, after which the questionnaire was refined. The target group of the questionnaire was mainly project

managers in the software developing industry, and both of the pilot interviews were performed with people from this group.

After the interviews were performed, the answers were analysed with the purpose of finding patterns between the fire fighting phenomena and the characteristics of the projects. There were twelve characteristics of a project that were analysed compared to the problems experienced by the study participants. However, seven of these characteristics sid not give any information of value, since there are too few interviewees. The five characteristics that has been used in the analysis are:

- The size of the project.
- The focus of the project.
- The schedule of the project.
- The process that was used in the project.
- If there were any tools to help prevent problems.

Only the problems concerning requirements elicitation and management, and loosing key knowledge were addressed in the analysis, since only one or two people brought up the other problems that were discussed during the interviews, which was too little to draw any conclusions from.

8.3 Results and Analysis

The analysis showed that approximately 58.5% of the projects studied were having problems with requirements. More than 70% of those having problems with requirements had high demands on reaching the market quickly and thereby also had a tight schedule. The four largest telecommunications projects both in person months and lead-time have had problems with requirements. More than 70% of the projects with requirements problems used an established organisation wide development process. Five of the seven projects having problems with requirements had a risk management plan and/or contingency plan.

Three project managers brought up the problem of loosing key personnel in the middle of the project, because of the lack of data any connections with the characteristics of the project could not be established.

8.4 Conclusions

The two problems that were found in the study as being the main causes of fire fighting were problems with requirements and the management of them and the loss of key personnel in the middle of the project.

There is an indication that the problems with requirements are related to the size of the project, both when the time is measured in lead-time and in person months. It is also indicated that if the project is facing problems with requirements the schedule and/or budget are at risk of being broken.

A majority of the projects studied had a risk management plan however these often did not cover the type of problems that later occurred in the projects, which left an opening for these problems. Several of the projects did postmortems, but they had not had old postmortems available when planning the current project, this indicates that the spreading of knowledge about previous problems were lacking.

In order to minimise the risk of fire fighting in projects, organisations should put focus on a well functioning requirements management process, and the preservation of key knowledge.

All of the results from this study should be further examined, by looking at both successful and problematic projects. The reason for this is that looking at only problematic projects, as

this study has done, does not show if the problems are unique for fire fighting projects, or if it is common for all types of projects.

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APPENDIX A – THE QUESTIONNAIRE

Background questions

- What is your job description today?
- How long have you worked in the position that you have today?
- What have you worked with/as before?
- What educational background do you have?

Questions aimed at trying to establish if fire fighting has occurred in any project that the interviewee participated in.

- Have you ever participated in a project that faced unanticipated problems, which solution lead to new problems?
- Has any project you have participated in
- Focus on one particular problem that sticks out as the type case, when considering the previous points discussed about problems in projects.
    - Did the project:
        - Overrun budget?
        - Run over schedule
        - Have to add additional staff in a late stage?
        - End up not producing what the customer wanted?
        - Get cancelled
        - End up with patching solutions for problems?

Problem specific questions

- Describe the problem that occurred
- Why did the problem occur?
- Have you experienced this problem in other project?
- How was the problem handled when facing it?

Project specific questions

Characteristics of the project

- How large was the project?
    - How many people were involved in the project at the most, and in which phase was that?
    - What was the budget? (Can be measured in man-hours, man-months, man-years.)
    - For how long was the project planned to last? (How many weeks, months, or years?)
    - How long has the company you worked at existed when the project started?

- What type of product was the project focused at?

- Which was the project domain?
    - Was the domain previously familiar to you and the other project members?

- What was the purpose of the project?
    - Get the product on the market fast?
    - High quality product?

- Which were the basic conditions for the project?
    - Economical.

    - Technical.
    - Time-line.
    - Customer's interest in the project.

- To whom was the product focused?
    - The big masses.
    - Single end-customer.
    - Internal customer.

- Was an organisation wide development process used for the project?
    - Describe the process used for the project.

- Describe the project's organisation.
    - Was the project performed on different physical places?
    - Was there a time difference between the groups? (If performed in different countries.)
    - Had you and the project members worked together before?

Effect of the problem

- In which phase of the project was the problem discovered?

- Could the problem have been discovered earlier?
    - If so, how could it have been discovered?
    - If several answers are given, please prioritise which action would have made the greatest change.
    - Would the outcome of the project have been different if it had been discovered earlier?

What action was taken?

- Did there exist a knowledge/experience database from previous projects?
    - If yes, does the database contain knowledge about this kind of problem?
    - If yes, was it used to solve this problem?
    - If yes, what kind of information is stored in the database?

- Was there a risk management plan?
    - If so, why was the problem not discovered through it?

- Did the project have a contingency plan in case of problems?
    - If there was a contingency plan, was it used when facing a problem?

- How was the problem solved?
    - Was it a good solution?
        - If no, what would you do differently?
    - If the problem were not solved, how would you do it with the knowledge you have today?

- Was a root cause analysis of the problem done after the project?
    - Was the experience of the problem analysed and transferred to other projects in the organisation?
    - If it was transferred to other projects in the organisation, how was it done?

Summing up questions

- If you were to grade the project on a scale from 1-4 (one is the project did not work at all, and four is the project worked very good), what grade would you give the project
  - Economically (were you within budget)?
  - Technically (was it a good technical solution)?
  - Time-line (were you within schedule)?
  - On the customer's interest in the project (did the customer show interest and involvement)?

- Name three things you would do differently if you had done the project with the knowledge that you have now.

APPENDIX B – QUANTIFICATION OF RESULTS

The answers from each interview is transferred into the following chart.

Project specific	**Answer**
Did the project go over schedule?	Yes/No
Did the project go over budget?	Yes/No
Was additional personnel added to the project in a late stage?	Yes/No
Was the customer satisfied with the end-product?	Yes/No
Did the project end up with patching solutions?	Yes/No
Was the project cancelled?	Yes/No
How large was the project?	X person months X project months
Type of project	
Domain	
Goal	Fast to market/High quality
To whom was the project focused?	Big masses/Single end customer/Other
Familiarity of project	
Was the domain familiar from before?	Yes/No
Were the project members familiar from before?	Yes/No/Mixed
Was the project spread out on different localities?	Yes/No
If yes, was there a time difference?	Yes/No
Preconditions	
Was the project on a strict budget?	Yes/No
Was the project on a strict schedule?	Yes/No
Was the project technically advanced?	Yes/No
Was the customer involved in the progress of the project?	Yes/No
Was the process used in the project organisation wide or internal?	Organisation wide/Project specific
What type of development process was it?	
How old was the company within which the project was performed?	Younger than 10 years/ 10 years or older
Problem specific	
In which phase of the project was the problem discovered?	
Pre-study	
Analysis	
Design	
Implementation	
Testing	
Delivery	
Has the problem occurred in other projects?	Yes/No
Were there any existing tools for solving the problem?	
Risk Management plan	Yes/No
Contingency plan	Yes/No
Experience database	Yes/No
Documented root cause analysis	Yes/No

APPENDIX C – THE RESULTS

In this appendix the answers from each interview is presented.

Person A

Current position: System analyst with focus on requirements management.
Company: Large, international telecommunication company.
Length of current position: Six months.
Previous position(s): Project manager, designer, and unit manager.

One of the problems that Person A experienced was that personnel with key knowledge left the project and organisation in the middle of it and therefore it became hard or next to impossible to correct any defects in their code. This problem was handled by having those left in the project work extra time. Focus in the project was only put on the problem that they were facing at the moment, and little time was spent thinking about the consequences of the solutions used. The project in which Person A experienced these problems was performed in the organisation in which he/she works today, and in the role of project manager.

Another problem that was experienced in the same project was that the requirements came straight from the customer to the project with no middleman managing and analysing them before they were given to the developers. The consequence of this was that it was hard to understand the requirements and their purposes. This was handled the same way as other problems in the project, people had to work more and put extra time on adding functionality and handling defects caused by unevaluated decisions.

Project specific	**Answer**
Did the project go over schedule?	No
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	No
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	167 person months 13 project months
Type of project	
Domain	Telecommunication
Goal	Fast to market
To whom was the project focused?	Big masses
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Yes
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	Yes
Was the project technically advanced?	No
Was the customer involved in the progress of the project?	No
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	10 years or older
Problem specific	
In which phase of the project was the problem discovered?	Testing
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	Yes
Documented root cause analysis	Yes

Person B

Current position: Part-time project manager in pre-study and maintenance phases.
Company: Medium-size, international telecommunications company.
Length of current position: Two years.
Previous position(s): Integration and configuration manager.

The problem experienced by Person B was that activities were forgotten and discovered from time to time during the project. These activities were not found until they have to be done, which lead to quick and immediate implementation of them. The project in which Person B experienced these problems was performed in the organisation in which he/she works today, and in the role of integration and configuration manager.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	48 person months 6 project months
Type of project	
Domain	Telecommunication
Goal	Fast to market
To whom was the project focused?	Big masses
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Yes
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Analysis
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	No
Documented root cause analysis	No

Person C

Current position: Head project manager.
Company: Large, international telecommunications company.
Length of current position: Three years.
Previous position(s): Project manager for sub-projects, test manager, and tester.

Person C experienced the problem of changing directives about how the product should look and work. The reason for this is that the domain was new and therefore it was hard for those stating the requirements to know what and how they wanted it. A group of people was assigned the task of evaluating the requirements of the system and they highlighted that the changing directives might become a problem, so the project were aware of it before they were facing the fact. Once facing the problem a group of people was assigned the task of solving it and was isolated from all other tasks and people. The project in which Person C experienced this problem was performed in the organisation in which he/she works today, and in the role that he/she currently holds.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	600 person months 18 project months
Type of project	
Domain	Telecommunication
Goal	Fast to market with quality
To whom was the project focused?	Single end customer
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Mixed
Was the project spread out on different localities?	Yes
If yes, was there a time difference?	Yes
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	No
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	10 years or older
Problem specific	
In which phase of the project was the problem discovered?	Testing
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	No
Documented root cause analysis	No

Person D

Current position: Test manager.
Company: Stately organisation.
Length of current position: One year.
Previous position(s): Developer and consultant.

Person D was faced with the problem that key personnel left the project when the company was reorganising, but the deadline of the project remained. Roles were changing, which caused unclear communication lines. Another consequence of the reorganisation was that key competences disappeared. To solve these problems the project had to try and contact the previous personnel and prolong the contracts of some consultants. The delivery ended up not containing all desired functionality. The project in which Person D experienced these problems was performed in the organisation in which he/she works today, and in the role that he/she currently holds.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	No
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	500 person months 36 project months
Type of project	
Domain	Business related
Goal	Quality
To whom was the project focused?	Big masses
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Mixed
Was the project spread out on different localities?	Yes
If yes, was there a time difference?	No
Preconditions	
Was the project on a strict budget?	No
Was the project on a strict schedule?	No
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	10 years or older
Problem specific	
In which phase of the project was the problem discovered?	Pre-study
Has the problem occurred in other projects?	No
Were there any existing tools for solving the problem?	
Risk Management plan	No
Contingency plan	Yes
Experience database	No
Documented root cause analysis	No

Person E

Current position: Project manager.
Company: Large, international telecommunications company.
Length of current position: One year.
Previous position(s): Project manager and teacher.

The problem the Person E discussed was that the sub-contractor had not provided the project with a system that fulfilled the functionality required, which caused to system to crash during the customer's final testing of the system. This problem was solved by a contract with the sub-contractor to put in support personnel and the project personnel had to work over time to update their parts. The project in which Person E experienced these problems was performed in the organisation in which he/she works today, and in the role of project manager.

Project specific	**Answer**
Did the project go over schedule?	No
Did the project go over budget?	No
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	80 person months
	5 project months
Type of project	
Domain	Telecommunication
Goal	Fast to market
To whom was the project focused?	Big masses
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Mixed
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	No
Was the project on a strict schedule?	No
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	10 years or older
Problem specific	
In which phase of the project was the problem discovered?	Delivery
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	No
Contingency plan	Yes
Experience database	No
Documented root cause analysis	Yes

Person F

Current position: Region manager.
Company: Consultancy firm in the Baltic region.
Length of current position: Two and a half years.
Previous position(s): Tester, customer projects, system development, and project management.

Both the customer and the project team were immature in working in projects and therefore the problem of unclear requirements emerged in the project that Person F discussed. Assumptions were made on both parts, the customer felt they had been extremely clear and the project group interpreted the requirements requested from the customer. This was handled by the project manager sitting down with both the project team and the customer and went through the most common aspects of working in a project. The project in which Person F experienced these problems was performed in an organisation for which Person F worked as a consultant, and in the role of project manager.

Project specific	**Answer**
Did the project go over schedule?	No
Did the project go over budget?	No
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	No
Was the project cancelled?	No
How large was the project?	34 person months 12 project months
Type of project	
Domain	Resource Management
Goal	Quality
To whom was the project focused?	Single end customer
Familiarity of project	
Was the domain familiar from before?	No
Were the project members familiar from before?	No
Was the project spread out on different localities?	Yes
If yes, was there a time difference?	No
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	No
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Implementation
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	No
Contingency plan	No
Experience database	No
Documented root cause analysis	No

Person G

Current position: Consultant (as project manager, test manager, and course coach).
Company: Small, national consultancy firm.
Length of current position: Six years.
Previous position(s): Application developer.

The problem that Person G brought up was that of lacking documentation in a project. Key personnel left and the knowledge about the system design had not been documented. This lead to more time having to be put on the design task by the remaining personnel, and as the project members gained more knowledge of the design; the budget of the project became increasingly large. The project in which Person G experienced these problems was performed in an organisation for which he worked as a consultant in the role of project manager.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	No
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	94 person months 6 project months
Type of project	
Domain	Telecommunications
Goal	Fast to marked
To whom was the project focused?	Single end customer
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Mixed
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	10 years or older
Problem specific	
In which phase of the project was the problem discovered?	Pre-study
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	No
Documented root cause analysis	No

Person H

Current position: Senior project manager.
Company: Consultancy firm in the Baltic region.
Length of current position: Three years.
Precious position(s): Teacher and project manager.

The problems that Person H discussed was that the project was performed in a young organisation and four different consultancy firms were involved, Person H was working for one of these. This lead to it being hard to put up any rules for how to perform the work and the development process that was to be used was still so new so it was rather unstable. The requirements on the system were also difficult to extract, since all persons involved had their view on the system. This caused Person H, who was the project manager, to leave the project. The organisation for which the project was to be done did a reorganisation in hopes of salvaging the project.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	No
Did the project end up with patching solutions?	Yes
Was the project cancelled?	Yes
How large was the project?	567 person months 28 project months
Type of project	
Domain	Telecommunications
Goal	Fast to market
To whom was the project focused?	Internal customer
Familiarity of project	
Was the domain familiar from before?	No
Were the project members familiar from before?	No
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	No
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Pre-study
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	No
Contingency plan	Yes
Experience database	Yes
Documented root cause analysis	No

Person I

Current position: Project manager.
Company: Private consultancy company.
Length of current position: One year.
Previous position(s): Project manager and IT-consultant.

Person I had experienced the problems of culture crashes, which lead to communication problems, and he had also had the problem that the seller of the system had promised functionalities that were not available. The reason for the culture crash and communication problem was that the consultancy firm that Person I was working for, were American while the customer were from Sweden. This caused a different view on money and how things should be done. The project manager burnt out and had to be replaced by Person I. Finally to solve these problems sellers from Sweden were brought in to ease the communication between the customer and the consultancy firm.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	No
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	112 person months 17 project months
Type of project	
Domain	E-mail
Goal	Quality
To whom was the project focused?	Single end customer
Familiarity of project	
Was the domain familiar from before?	No
Were the project members familiar from before?	No
Was the project spread out on different localities?	No
If yes, was there a time difference?	
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	No
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	No
Was the process used in the project organisation wide or internal?	Project specific
What type of development process was it?	Waterfall model
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Delivery
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	No
Documented root cause analysis	Yes

Person J

Current position: Project manager.
Company: Small, national consultancy firm.
Length of current position: Two years.
Previous position(s): Project manager and account manager.

The problems that Person J experienced were connected to the requirements of the system to be developed. The expectations of the customer and the developing organisation were not the same. The customer was not sure on what he really wanted, and the development team expected the customer to know more about the process of software development than he did. The problems were discovered when the requirements phase kept on getting dragged out and seemed endless. In order to solve the problems, a prototype group consisting of one representative from the customer and two representatives from the development organisation was created and "locked up" until a frozen requirements specification had been created and agreed upon. Person J was working in his current position.

Project specific	**Answer**
Did the project go over schedule?	Yes
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	No
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	No
Was the project cancelled?	No
How large was the project?	60 person months 16 project months
Type of project	
Domain	Business-oriented
Goal	Quality
To whom was the project focused?	Single end-customer
Familiarity of project	
Was the domain familiar from before?	No
Were the project members familiar from before?	Yes
Was the project spread out on different localities?	No
If yes, was there a time difference?	No
Preconditions	
Was the project on a strict budget?	Yes
Was the project on a strict schedule?	No
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Project specific
What type of development process was it?	Waterfall
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Pre-study
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	Yes
Documented root cause analysis	Yes

Person K

Current position: Software architect.
Company: Small, national consultancy firm.
Length of current position: Two years.
Previous position(s): System developer, software architect, and project manager.

The problems that Person K brought up was that the customer did not know what he or the market he was aiming at really wanted. To minimise this problem prototypes were created and shown to the customer, but since the data was simulated the prototype gave a false image of the system. The solution to this problem was that a new running price project was started after the delivery in order to provide the functionality that had not been possible to provide in the original fixed price project. Person K was working for another organisation than today, and in the role of project manager.

Another problem that was experienced was a plan with weaknesses, which lead to new activities being discovered and estimates that were inaccurate. The reason for this problem with planning was that it was the first large software development project in the organisation. The solution was to let project members work overtime.

Project specific	**Answer**
Did the project go over schedule?	No
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	No
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	40 person months 8 project months
Type of project	
Domain	Business-oriented
Goal	Fast to market
To whom was the project focused?	Single end-customer
Familiarity of project	
Was the domain familiar from before?	Yes
Were the project members familiar from before?	Mixed
Was the project spread out on different localities?	Yes
If yes, was there a time difference?	No
Preconditions	
Was the project on a strict budget?	No
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	No
Was the process used in the project organisation wide or internal?	Project specific
What type of development process was it?	Evolutionary
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Delivery
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	No
Experience database	No
Documented root cause analysis	Yes

Person L

Current position: Project manager.
Company: Medium-size, international telecommunications company.
Length of current position: Two years.
Previous position(s): Developer and team leader.

The ground of the fire fighting problems in the project experienced by Person L was the lack of clear requirements. During the project new ones were constantly discovered and were added, and since the requirements management was ad-hoc, this was done without consideration of how they would affect the requirements that had already been decided on. These ad-hoc implementations without change control lead to a steady stream of problems that had to be solved. The solution to the problem was just to face it as it came and make a quick patch. Person L was during this project working in the same organisation as today, and in the role of project manager.

Project specific	**Answer**
Did the project go over schedule?	No
Did the project go over budget?	Yes
Was additional personnel added to the project in a late stage?	Yes
Was the customer satisfied with the end-product?	Yes
Did the project end up with patching solutions?	Yes
Was the project cancelled?	No
How large was the project?	540 person months 18 project months
Type of project	
Domain	Telecommunications
Goal	Fast to market with quality
To whom was the project focused?	Big masses
Familiarity of project	
Was the domain familiar from before?	No
Were the project members familiar from before?	Yes
Was the project spread out on different localities?	Yes
If yes, was there a time difference?	No
Preconditions	
Was the project on a strict budget?	No
Was the project on a strict schedule?	Yes
Was the project technically advanced?	Yes
Was the customer involved in the progress of the project?	Yes
Was the process used in the project organisation wide or internal?	Organisation wide
What type of development process was it?	Incremental
How old was the company within which the project was performed?	Younger than 10 years
Problem specific	
In which phase of the project was the problem discovered?	Testing
Has the problem occurred in other projects?	Yes
Were there any existing tools for solving the problem?	
Risk Management plan	Yes
Contingency plan	Yes
Experience database	Yes
Documented root cause analysis	Yes

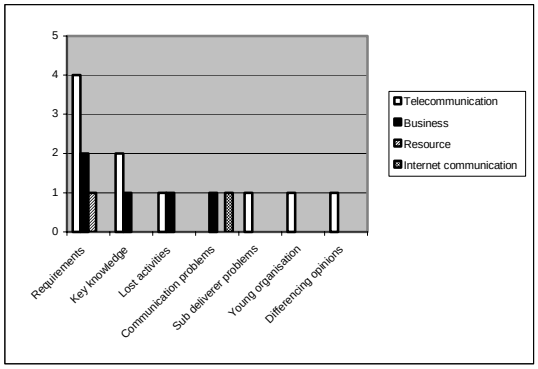
APPENDIX D – COMPLETE ANALYSIS

In this appendix all the problems are analysed in relation to the following twelve project characteristics.

- The domain of the project.
- The size of the project.
- The focus of the project.
- The budget of the project.
- The schedule of the project.
- The technical complexity of the project.
- The customer's interest in the project.
- The target group of the project.
- The process that was used in the project.
- If the project was local or spread out on different places.
- If there were any tools to help prevent problems.
- If a root cause analysis was performed after the project was finished.

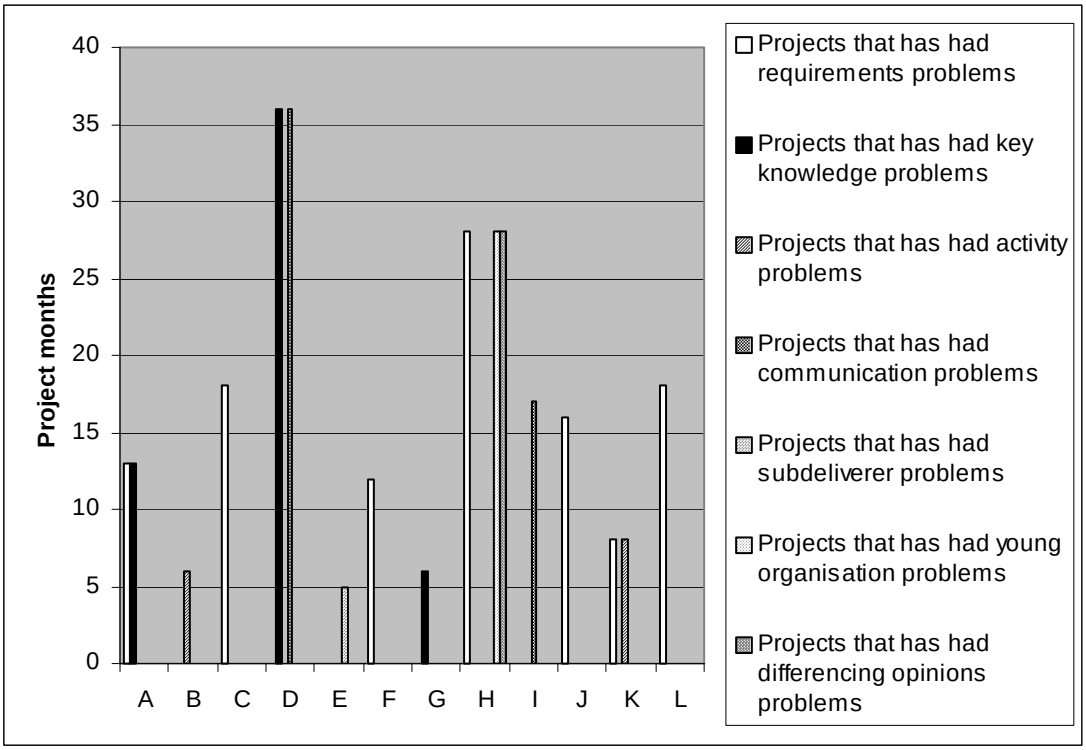
Domain

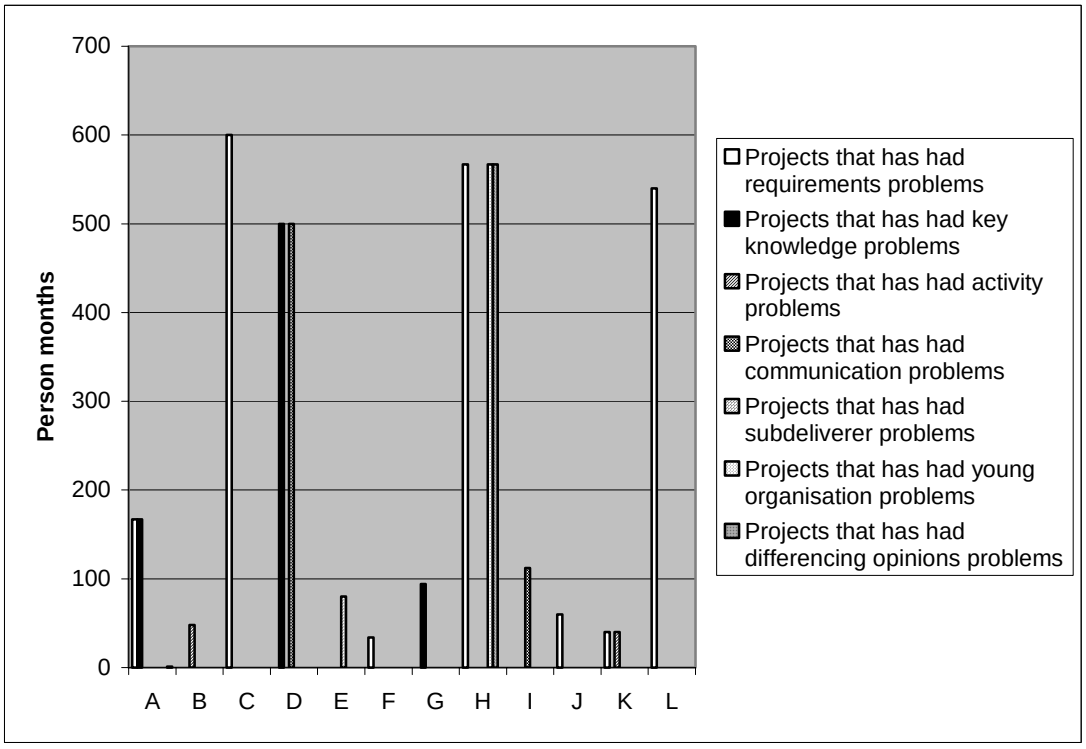
The domains of the studied projects are telecommunication, business, Internet communication, and resource management.



The figure shows the relation between the domains of the projects and the type of problems that were experienced.

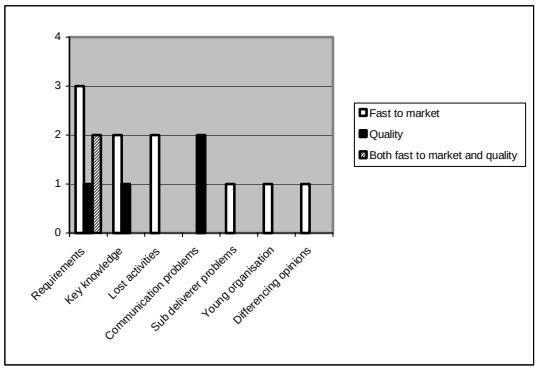
Project size





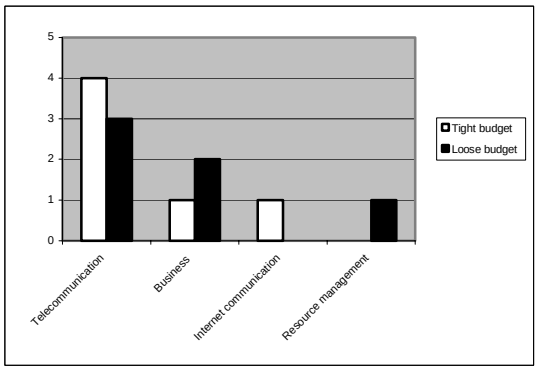
The first figure shows the connection between the lead-time of the projects and the type of problems that were experienced. The second figure shows the relation between person months and the problems that occurred in the projects.

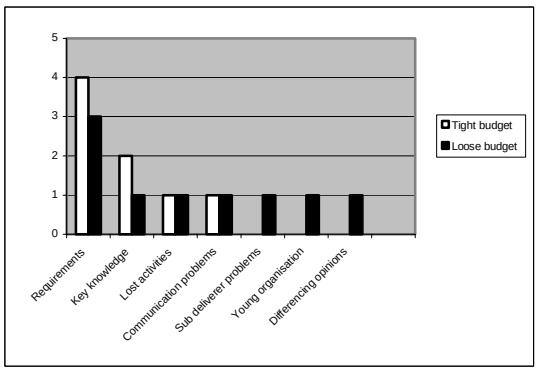
Project focus



The figure shows the relation between the types of problems that were experienced in the projects and the focus of the projects.

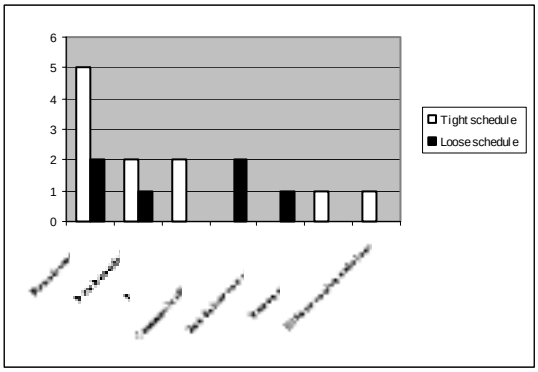
Budget





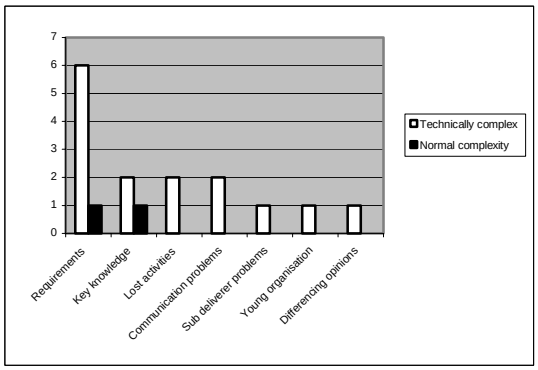
The first figure shows which type of budget the projects had, distributed over the domains. The second figure shows the type of problems that occurred and the relation of this to the budget of the project.

Schedule



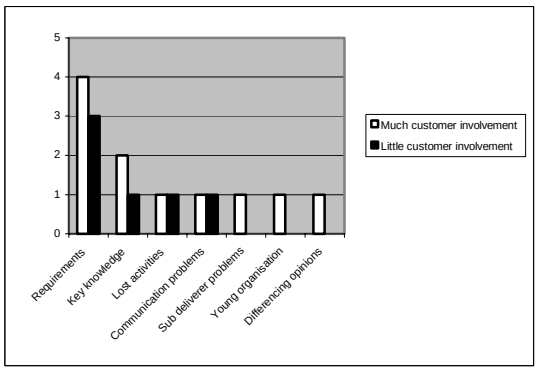
The figure shows the type of schedule the projects were on compared to the type of problems that occurred.

Technical complexity



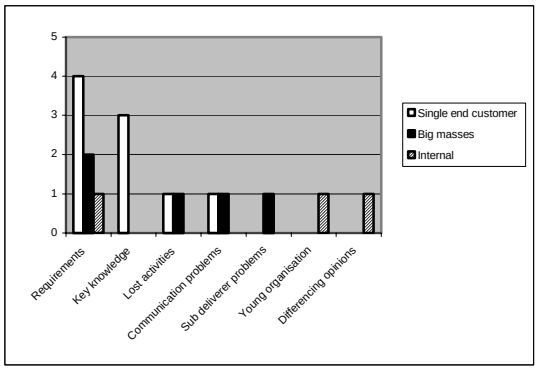
In the figure the relation between the type of problem that occurred in the projects and the technical complexity of them is shown.

Customer involvement



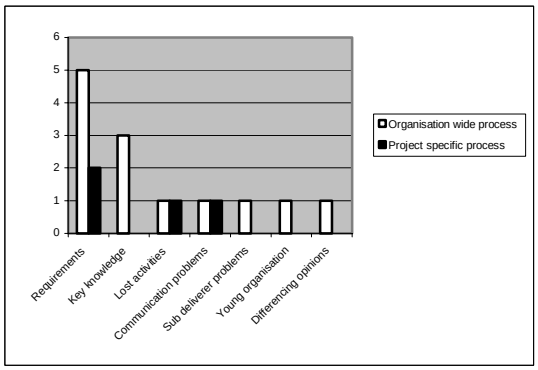
When a customer is involved in the progress of the project the risk of delivering the wrong product is minimised. This figure shows the relation between the problems that occurred and whether or not the customer was involved in the progress of the project.

Focus group of the project



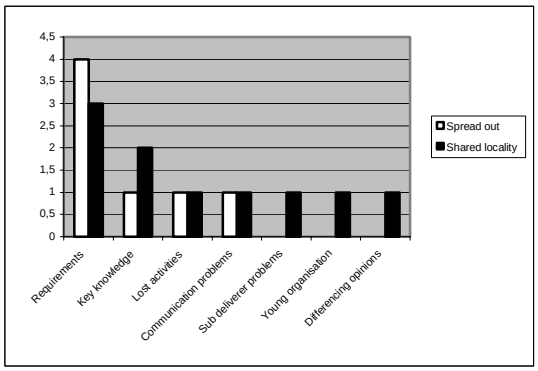
The figure gives and overview of the connection between the problems that occurred in the studied projects and the target group of the end product.

Project process



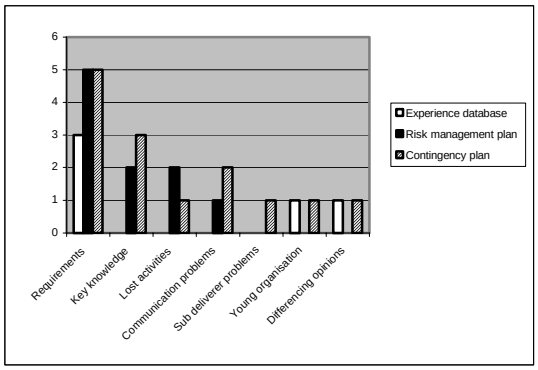
A majority of the projects studied used and organisation wide development process. In the figure the relation between the types of problems and the process used is shown.

Localities



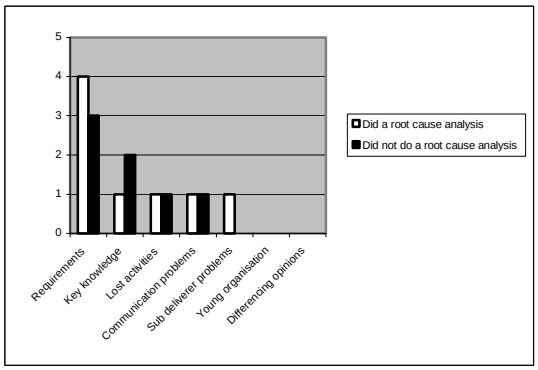
Most projects in the study shared common localities and therefore could easily meet and discuss different aspects of the project. The figure gives an overview of the types of problems that occurred and the location of the project.

Tools



Several tools can be used to minimise the risk of fire fighting. In the figure the use of such tools in the problematic projects are shown.

Root cause analysis



In order to prevent the same problems from occurring in later projects, the organisations can do a root cause analysis at the end of the project. The figure shows how many of the problematic projects that actually did the analysis after wards.