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Risk management in small construction projects

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I dedicate this thesis to my dear friend, Helena Turtola, who was taken from me and the rest of the persons who treasured her, too early and too abruptly.

"I will always keep you close in my mind Helena and I do continue my research..."

Acknowledgements

This study has been made possible thanks to the many persons in my surroundings. It began with trusting my idea of doing research in the field of risk management with a focus on the everyday project in the construction sector. Thank you Assistant Professor Lennart Apleberger, my supervisor, Professor Jan Borgbrant my scientific supervisor and examiner, Luleå University of Technology, and Jan Byfors, NCC, for trusting me and supporting me in this work, taking my idea to a complete licentiate thesis. There has also been great support from my wonderful group of reference persons, Peter Gjörup and Ingegerd Simonsson from NCC, Anders Lundgren, LKAB, PO Larsson-Kråik, Banverket, and Kalle Nylén, Byrå Idun, and Richard Espling from Skanska, thank you for all the energy you give me each time we meet. I also want to thank my assistant supervisor, Assistant Professor Per Anders Akersten, for his clever and valuable discussions about risks. As well, a special thanks to Kalle Nylén for his invaluable help throughout this work – Kalle, I wouldn't have done it without you!

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Luleå, Oktober 2006
Kajsa Simu

Sammanfattning

Den svenska byggsektorn har brottats med problem som resulterar i fördyrade byggkostnader, förseningar och byggfel. För att komma till rätta med dessa problem tillsatte regeringen en kommission som 2002 presenterade sin rapport Skärpning gubbar. I rapporten konstateras att det trots insatser på kvalitetssystem och utökad egenkontroll inte gett önskvärda resultat.

Riskhantering handlar om att kunna förutse och beräkna risker och osäkerheter i ett projekt och ofta utgör det en del av de kvalitetssystem som tillämpas i företagen idag. De system som tagits fram har i huvudsak fokuserat på medelstora till stora projekt och de små projektens behov, förutsättningar och tillämpning av systemen har lämnats därhän. De små projekten utgör dock en väsentlig del av den svenska byggbranschen, 83 % av antalet projekt är mindre än 15 miljoner sek. Många små förluster här ger i slutändan stort ekonomisk utfall på grund av antalet små projekt under ett år.

I den här studien har forskningsfrågorna fokuserat på att ta reda på hur de små projekten hanterar risker samt hur väl de teoretiska ramverken inom riskhantering stämmer med de rutiner och riktlinjer som finns i de undersökta byggföretagen. Utöver detta inkluderar studien en genomgång av tidigare forskning inom riskhantering i byggprojekt. Slutligen har även studien sökt svar på vad som verkar som hinder och drivkrafter för att tillämpa riskhantering i små projekt.

För att få svar på dessa forskningsfrågor har en intervjustudie genomförts och triangulerats med dokument- och litteraturstudier. Utifrån 10 entreprenadprojekt har tre nyckelroller; platschef, arbetschef[1] och byggledare, i varje projekt intervjuats, totalt 28 intervjuer.

Resultaten från den här studien visar att;

- det finns behov av förbättringar av riskhantering i små projekt
- det finns brister i såväl systematik som tillämpning
- att utbildning inom riskhantering är låg, näst intill obefintlig, i de undersökta projekten
- att tilliten till egen erfarenhet och bakgrund är hög
- att de verktyg som används mest är olika former av checklistor

Det visar sig även att systemen i sig upplevs mer som hinder än som stöd för en effektiv riskhantering. Det finns en frustration över alltför omfattande rutiner. De arbetssätt som används kan dock knappast anses uppfylla kriterierna för systematisk riskhantering. Det som är av betydelse för hur riskhanteringen har fungerat i dessa projekt beror till stor del

[1] Arbetschef, affärschef eller motsvarande hos byggentreprenör.

på individen och dennes personliga bedömningar. De verksamhetssystem som finns har inte varit avgörande eller i vissa fall ens till någon nytta. Sammanställning från tidigare forskning visar på liknande resultat

Såväl rapporten Skärpning gubbar, tidigare forskning och resultaten från den här forskningen visar att användandet av verksamhetssystem inte räcker för att få en effektiv styrning av byggprojekt. I den här rapporten föreslås att den fortsatta forskningen inom detta område ska fokuseras på individer och deras riskattityder, samt på riskkulturen och riskmognaden inom företag och bransch.

Abstract

The Swedish construction sector has for some time struggled with problems that result in increased costs, delays and faults. To sort out and analyse these problems, the federal government appointed a commission that produced the report "Skärpning gubbar" (2002). This report highlights that despite ongoing work with quality management and internal quality surveillance, improvements still lack. Risk management is about thinking ahead and calculating the risks and uncertainties involved in a project, which is most often part of the quality management system in an organization. The systems available have been developed to focus on medium to large sized projects, leaving behind the smaller projects needs, conditions and application. However, the smaller projects are an essential part of the construction sector, with 83% of all projects smaller than 15 MSEK.

In this study the research questions have focused on the smaller projects and their tools and methods to handle risks, and how the theoretical framework in the field of risk management corresponds to routines in the involved companies. The study also presents previous research in the field of risk management in construction. Finally, the drivers and obstacles for risk management in small projects are also focused upon.

An interview study was carried out to answer the research questions. Triangulation was done using document and literature searches. Ten projects were involved with three key role individuals in each; site manager and project managers from the client and construction company, totaling 28 interviews.

The results from this study show a need for improvements regarding risk management in small sized construction projects. Present risk management lacks both system and application. The results also show that risk management education and training is low, almost non-existent, in the studied projects. Also, the management system is more of an obstacle than of beneficial use for efficient risk management, with frustrating routines that are too extensive. Previous research similar to this study shows that the reliance on the individual experience and background is high and that the most commonly used tools are different types of checklists. This could, however, not be considered systematic risk management. Critical to how risk management works at site are the individuals and their judgments. The management systems adopted on site have not been essential or in some cases not even of any use.
This thesis, as well as the report "Skärpning gubbar" (2002), and previous research, show that merely using management systems is not enough to attain efficient control of construction projects. This thesis suggests continuing with research that focuses on the individuals and their attitudes, the organizations culture and the maturity in relation to risk and risk management.

Appendix

Description of expressions

AB Allmänna bestämmelser

General agreements on construction contracts applicable in Sweden

AB04

General agreements valid from 2004, applicable for general contracts.

ABT94

General agreements valid from 1994, for build and design contracts.

AML

Arbetsmiljölagen, the Work Environmental Act passed by Sweden parliament.

Aleatory risk

Random risk, possible set of outcomes is known but the quantities of consequence and probability is not known even though they are calculable

CAR

Construction all risk, insurance that covers the building contract, the existing property and the work aid at site.

Client

Person or organization that commission buildings or constructions for themselves or for someone else.

'Doers'

Category of individuals in this thesis that have a practical way of controlling the construction project.

Epistemic risk

Lack of knowledge about possible outcomes. Lack of knowledge about what you do not know.

'Frustrated'

Category of individuals in this thesis that show much frustration in their work regarding their quality management systems.

Inflicted uncertainty

Uncertainty that is inflicted in project organisations by actors' inability to learn from previous projects

Management system

The structured way, in which organizations chose to control their business, including such ingredients as economy, organization and problem solving. Examples of management systems are quality management systems, environmental management systems, knowledge management system.

Project Manager

Person that is closely involved in the construction project either as superior to the site manager or as the clients representative, closest to the project.

Risk

Risk is defined as something that occurs and which was neither foreseen in the project description nor in the contract, often being caused by lack of knowledge with one or many of the parties involved.

Site manager

The person responsible for the project on the construction site.

'Sytem users'

Category of individuals in this thesis that use and benefit from their companies quality management systems.

Uncertainty

An overarching term that could have two possible outcomes, a risk or an opportunity

'Wanna bes'

Category of individuals in this thesis that would prefer having a management system but lack it in their present work situation.

1 Introduction

The construction industry has a long history. Housing has been built ever since humans left caves and the construction project as a business branch has probably been around since before the pyramids. There have always been considerations about uncertainties and risk. This is a study that captures the work in minor construction projects today regarding risk management. The aim of this chapter is to give an understanding of the context and purpose of the study.

1.1 Background and problem formulation

The construction sector in Sweden has for some time suffered from poor performance and a lack of control in various steps of the process. Due to the sector's problems with numerous faults and the increased costs for buildings, the Swedish government initiated the Building Commission, whose assignment was to focus on where the problems were and how to increase the effectiveness instead of the costs. They found, amongst other things, problems with cost and faults related to the construction. Risks and other uncertainties can cause losses that lead to increased costs, time delays and lack of quality during the progression of the projects and at their end. The Commission also found that quality management systems according to the ISO standard 9000 have not been enough to decrease the problems in the sector ("Skärpning Gubbar" SOU_2002:115, 2002).

Risks and uncertainties appear in various shapes. In projects the objectives are most often related to time, cost, quality and function and client satisfaction (Hillson, 2004). In organisations, depending on the risk management focus, different relations between the objectives and the definition of risk exist. The risk definition is therefore highly dependent on the choice of applied management focus in the organisation. In the construction industry the management focus on site is closest related to what Hillson describe as project risk management and safety risk management. At other levels, apart from the project site, the focus is somewhat different.

Risk management is generally a part of other management systems such as quality, environmental or work environmental management systems. Some core values are common in many quality and environmental management systems viz. the commitment of all employees, customer focus, management commitment, focus on process, continuous improvement and fact-based decisions. These core values are closely connected and could easily be found in the theoretical framework of risk management. The current focus on risk management should be regarded as a complement and a development of the already implemented quality management systems used by companies. Either way, risk management is a crucial part of the total project management system regardless of the focus on quality, environment or work environment.

In the Swedish construction sector, the most common project is less than 15 MSEK (roughly €1.65m). According to Sveriges Byggindustrier (Hultén, 2004), as much as 83% of all projects range from 1-15 MSEK for 2003. At NCC the same figure was 68% (statistics from 2003 in NCC's internal economical control system).

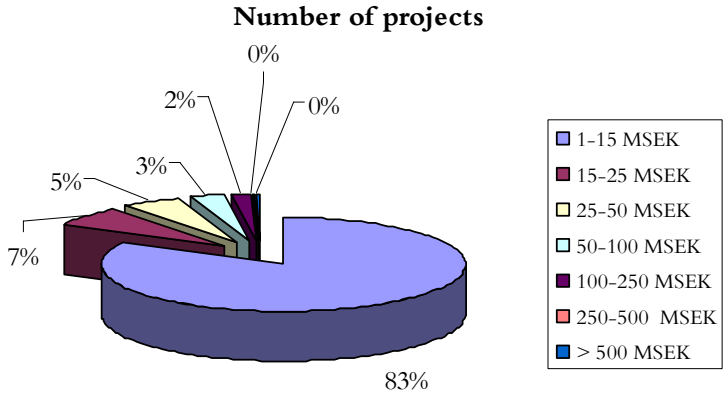

Figure 1. Number of projects divided into segments in relation to their size.(Sveriges byggindustrier, statistics from 2003, Hultén, 2004)

The distribution of projects in each segment, sorted by monetary value, instead of the number of projects is also interesting. For the Swedish construction sector, the figure would then be 21% (Hultén, 2004) and for NCC 24%. Clearly, a large portion of the work done in the construction sector concerns the small-scale projects environment. The projects in the span 1-15 MSEK are not as dominant in Figure 2 but still represent countable volumes. Projects up to 50 MSEK represent half of the sector turnover. The smaller projects, regardless of the definite limit, represent countable volumes in both numbers and monetary value.

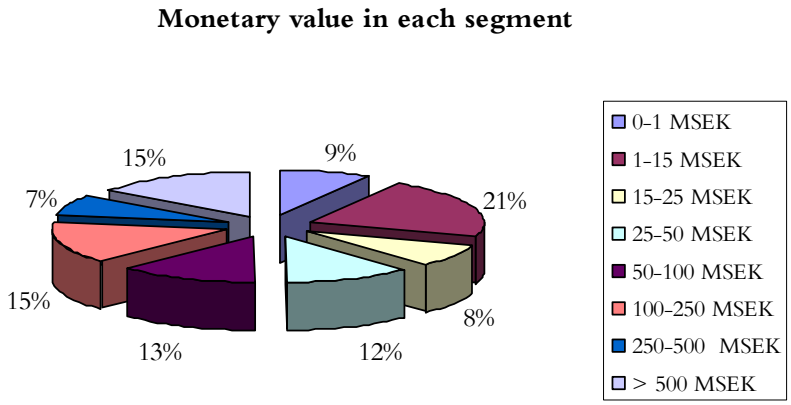

Figure 2. Monetary value in each segment (Statistics from 2003, Sveriges byggindustrier, Hultén, 2004))

Management systems, where risk management is or should be included, are widely used in the sector. From the researcher's experience of working with management systems the knowledge of the special conditions for the small projects is derived. For small projects, it is more or less the same system used as for larger projects within the same organisation. There are routines and forms to be used regardless of the project's context. In small projects a common reaction is that the system interferes in the crucial planning of the project instead of supporting it. In the larger projects, the project's organisation has the resources and time to use the management system in a different way and thus achieve support from it. There is also more time during the larger projects to plan and think several steps ahead, as well as more people involved who increase the benefits from meetings and teamwork. Management systems are often written with focus on a project's size to include at least two managers on site. For smaller projects, site managers often run two projects simultaneously, leaving little time to sit down and follow the management systems' routines and guidelines. This might not be a problem, but could lead to the smaller projects making shortcuts that are fatal to the risk outbreak in the project. It is then interesting to find out how these possible shortcuts are done. Finding out how construction project managers handle risks and uncertainties everyday could increase the possibilities to work more efficiently.

The standard agreement for contracts in the construction industry in Sweden is Allmänna Bestämmelser (AB), with different agreements depending on the form of the contract undertaken. AB04 is for general contracts and ABT94 is for build and design contracts. The Construction Contracts Committee (Byggandets Kontraktskommitté, BKK) representing various actors in the Swedish construction industry prepares these general agreements.

The general agreements regulate the responsibilities and undertakings in the contracts based on a balance between rights and responsibilities between the actors (contractor and client) with the purpose to achieve an optimal risk distribution regarding the finances. Who is responsible for design and who is responsible for construction are clearly defined. In the general contract, only the contractor is responsible for the construction and any uncertainty in the design is the client's responsibility. This gives the contractor the right to get any adjustments and occasionally compensation within the contract. This right is in some cases regarded as a possibility to compensate for a poor contract, and the willingness to alleviate any uncertainties before signing the contract is limited from the contractors' perspective. However, the clients are well aware of this and regard any questions and discrepancies from contractual documents as attempts to squeeze out some more money for the work to be done. Small projects are more vulnerable to changes and additions in contractual agreements; hence, the need to plan ahead for uncertainties should be high. The hypothesis that this is not working as effectively as it should highlights the need to know more about how risks and uncertainties are handled in small projects.

Actors in the Swedish construction sector are strongly recommended to not deviate from the general agreements. One reason is the insurance agreements within the sector. Contracts that deviate from the general agreements of AB are not covered by insurance today (Hellström, 2006). It is therefore of great importance that the individuals who sign the contracts be fully aware of this. The smaller the project the more responsibility on the site and project manager due to the limited personnel resources of the smaller projects. By comparison, there is often more support from specialists in a larger project and the probability of discovering deviations from the general agreements (AB) is therefore greater.

Insurances within the sector are divided into Construction All Risk, CAR and Liability insurances, each in excess is 100,000 SEK (10,000 €). According to M Hellström (Hellström, 2006), Risk Manager at NCC Group AB, there are at least as many losses in the segment of 25,000- 100,000 SEK as there are in the segment 100,000 – 200,000 SEK, with the only difference being that no follow up exists with losses below 100,000 SEK. Hellström makes his estimates the contacts taken by production managers when they are at a loss situation. For a small contract, the excess of 100,000 SEK could be quite large, in regards to percent of the contract sum. The security of the CAR or Liability incurrence is therefore limited. The other limitation and problem with the available insurances are their limited extent, or rather, the limited knowledge about their scope (Hellström, 2006).

Previous studies in the field of risk management in construction tend to cover large-scale projects, often with many different participants (Ahlenius, 1999; Staffan Hintze, 1994; S

Hintze *et al.*, 2003; Jaafari, 2001). The risks cover a spectrum of events from financial, political and legal to technical, often related to complex constructions. There are also studies that focus on the usage of risk management in construction, with the client and contractor perspective but have a top-down approach. No research found focuses on small sized projects, from the project site perspective. In small sized projects, the risks are more moderate and the consequences are less dramatic. These projects are more vulnerable to changes that have an impact on time, since there is less chance of catching up if the schedule slips. However, the nature of the construction work and the project environments are often rather straightforward and the technical challenge is limited. This picture of small sized construction projects is based on the researcher's personal observations and that of the study's reference group[2].

Risks related to the work environment are highly regulated by laws and regulations. The Swedish Work Environment Authority works under the statuary foundations laid in the Work Environment Act (AML) passed by the Riksdag (Sweden's parliament). The detailed regulations on the subject are then issued by the Work Environment Authority through Provisions and General recommendations. There are clear descriptions for what is to be done and by whom. In the construction sector, these laws and regulations are well established and the client and contractor take common responsibility for these tasks. The usual way is for the clients to delegate the practical work to the main contractor, who coordinates this work on site. The main contractor then works out the documents declared by the AML, such as risk analyses regarding work environmental risks and a management plan for work environment.

With this description of the context for the small sized projects the problem formulation has emerged. There is not one cause for the problems described as there is probably not one single solution. In this introduction the scene and the different matters affecting the project situation is set for the reader to understand where and why the aims and research questions have been developed.

[2] Group of reference is made up of representatives from Construction related industry in Sweden

1.2 Aim and research motives

In this research the aim is to uncover how risk management is carried out in small sized projects. The contribution of the study is to reach an understanding of the risk process. If a greater understanding about the issues in small sized projects is achieved, it will be easier to focus on the right efforts of the companies to increase value in the construction process. The research questions for this study are:

- What are the methods and tools for risk management in small construction projects?
- How are these methods and tools used?

- What kind of risk management is applied in the construction companies' management systems?

- What are the results from previous research done in the field of risk management in construction processes?

- What are the obstacles and drivers for risk management in small sized construction projects?

These research questions are formulated with the ambition to enlighten the work with risks in construction projects. The first two questions address the practical work at site level, whose answers are sought after in the empirical results of the study. The third question addresses the relation between risk management and applied management systems in the construction companies. The answers to this are relevant, since this is part of the project context for the projects involved and the answers are sought in the empirical results and theories of risk management. The fourth research question addresses theories in the field of risk management, with the answers being sought in the subject literature. The relation between the research questions is illustrated in Figure 3, where the fifth research question ties them all together. The research questions cover different parts of the context for risk management in construction projects. Their relation and interference is tied together through a focus on obstacles and drivers for applying risk management

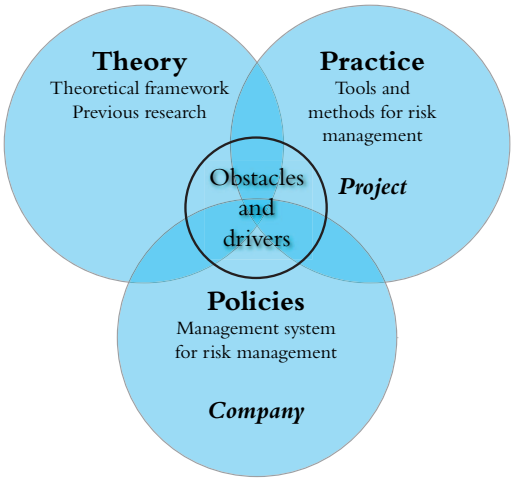

Figure 3. The different focuses in the research questions.

1.3 Delimitations

In this study, projects in the range of 1-15 MSEK have been chosen. The characteristics of a small sized project were subsequently discussed and agreed upon within this study's reference group. The resulting description is enough to distinguish these projects from very small projects that are more of continuous business operations and from larger projects at the other end of the scale. The characteristics of small sized projects agreed upon in the reference group, for the purpose of this study, are:

- contract value between 1-15 MSEK
- a site manager responsible for a maximum of two projects simultaneously
- limited construction time, maximum 12 months
- established technique, no development work
- project environment is independent
- personnel involved are more generalist than specialist

Projects in the range of 0-1 MSEK have been excluded because they are less interesting from a project risk management perspective. Their nature is inherently more like a continuous business than project-based. The upper limitation at 15 MSEK is chosen in accordance with the other parameters for a small sized project. When a project increases in volume, the organisation also increases. However, the absolute number for this is not defined, since it is related to the rest of the project context. To have a set number for obtaining the statistic data, the size limit of 15 MSEK was chosen.

The perspective sought is from the construction project's viewpoint at site level. The management systems used at projects are those of the construction companies and the clients' management system has therefore not been in focus. The projects are situated in a larger context as shown in Figure 4, where the project and the site managers are the main characters. The context of each project is briefly described and the empirical results for this study are collected from interviews and documents.

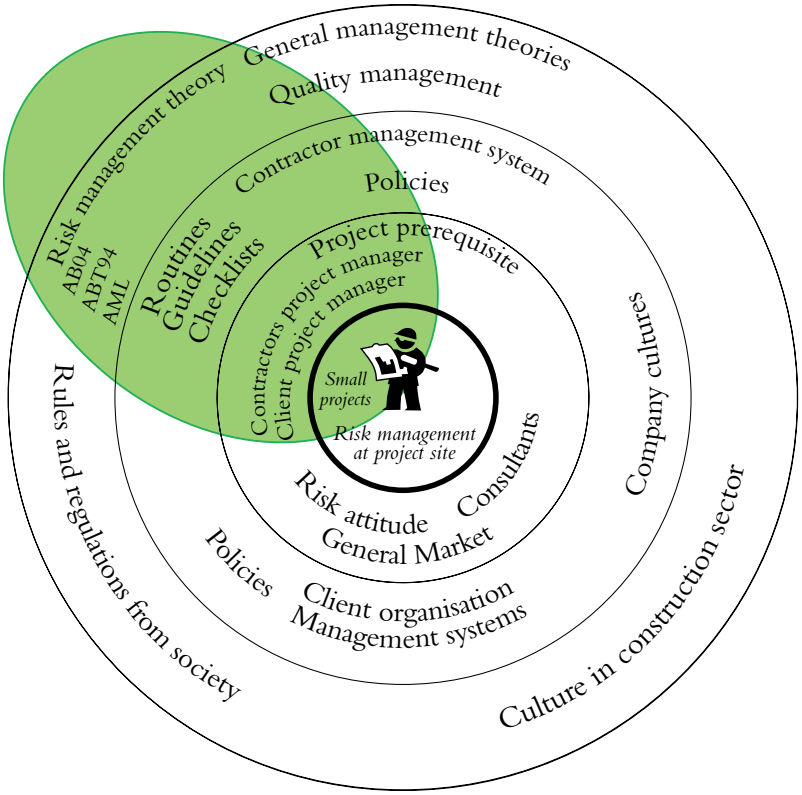

Figure 4. Delimitations for this study and the construction project in its context with the site perspective in focus.

2 Method

This chapter describes the method applied in this study, which is qualitative where matters such as influence from the researcher and chosen sources of information play an important role in the final results. In this chapter, the researcher, outlines for the interview survey and the selection of data sources are described in a chronological order.

2.1 Researcher's background

It is not possible to conduct research or analyse data in research without considering and being aware of the biases due to the researcher's background and the subjectivity of the researcher (Merriam, 1998). The knowledge derived in a study like this is most dependent on the researcher's skills and background. As (Kuhn, 1996) notes, `what a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see´.

My background is a MSc Civil Engineering, structural engineering, and thus my understanding of research is from the natural science. I started my career in the construction industry in 1995 as a trainee at NCC, one of Sweden's lager construction companies. During the trainee period, I worked as a site foreman and learned about project management from the practical side. After finishing my trainee period, I started working with and being part of developing NCC's environmental management system. In 2000, when NCC Civil Engineering, Sweden received accreditation for its environmental system ISO 14001, I was Chief Environmental Officer. The years prior to beginning this research project, I worked with quality and environmental management systems at a regional level of NCC Construction, situated in Luleå. This experience can be of strength if used properly. In this study, I have been able to tune into the respondents' use of language and terminology considered necessary in an interview situation. I have also used my years of experience and observation throughout the study to describe the background and problem formulation and to use as a complement to the empirical results. My background has permitted a better understanding of matters 'between the lines'. A potential bias is that the researcher could jump to conclusions based on her own experience instead of using/listening to information from the respondent. By being aware of this, I have made an effort to ask questions in a way that seeks explanations rather than `yes and no´ answers. I have also been aware of not talking in a language that is full of "professional expressions" from management systems. I have adapted to the practical environment found on a construction site.

2.2 Litterateur review

The literature review started out according to the delimitations set up in Chapter 1, Figure 4 and the chosen research questions. This study did not start with a literature search as a way to determine the research questions. The research questions were formulated from the background knowledge of the researcher.

Within the field of general management systems this study includes minor studies of quality management systems and thorough studies in the field of risk management. The literature review narrows down the area of risk management to the specific area of risk management in construction projects. The field of risk management is wide and spans from insurance and financial risk to the area of risks in work environment. The literature research delimits basically all research done outside the field of risk management in construction projects. For definitions, wider searches are conducted, though for the process the narrower approach is used, Figure 5 below. Between the areas of project risk management (PRM) and uncertainty management and PRM in construction there are connections. Also between research on large scale projects and other specified types of projects there are relations. These relations are illustrated with connecting arrows in Figure 5. The main sources for this literature research are literature databases, such as Ebsco, Emerald, Elsevier Science Direct, ByggDok, Compendex and Google Scholar. The searches for articles are complemented with searches within libraries in Sweden through Libris and at the university library at Queensland University of Technology, QUT.

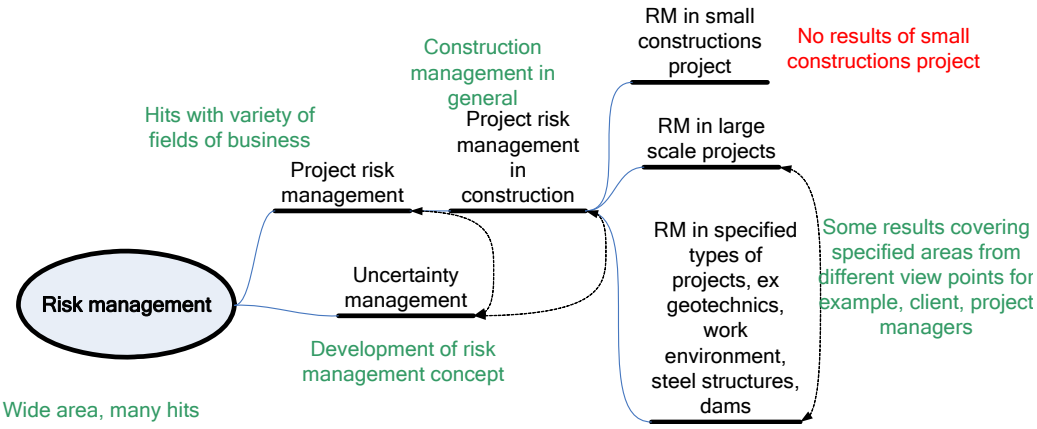

Figure 5. Process of literature search in field of risk management

To get an overview of the theoretical field the different authors are grouped in relation to their contribution to the knowledge. Figure 6 shows the authors that have had the greatest influence in the theoretical framework; it is not a summary of the full results from the literature review. The fields that form the basis of the theoretical framework in this study are those to the left, i.e. risk definition, risk management systems and risk management in construction. The fields to the right are very interesting and important but are excluded from further research in this thesis due to previous delimitations.

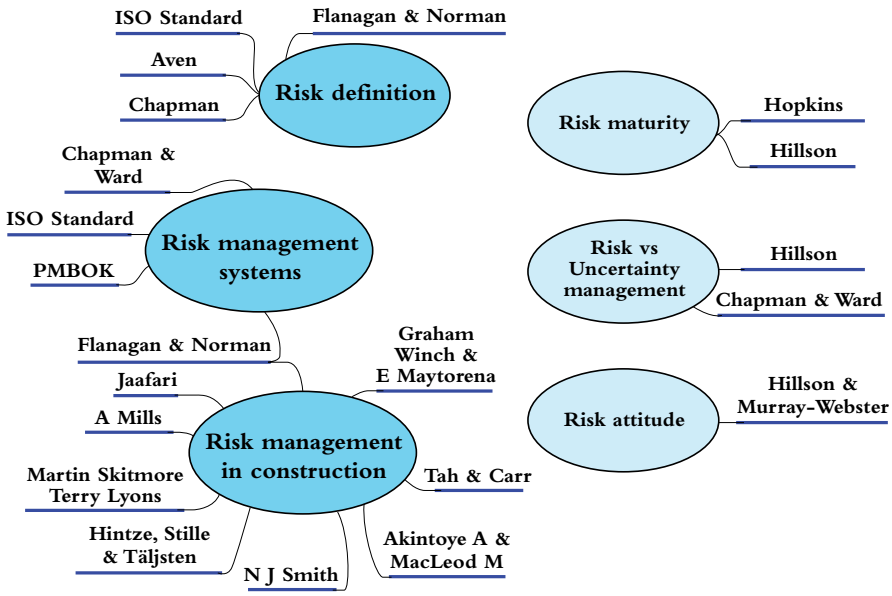

Figure 6. Parts of the results from the literature review

2.3 Research design

The research design is determined by considering how to link the research questions with the data collection and analysis and the yield of results. There are different ways to determine the best research design. The definitions of the different designs vary as well as the boundaries between them (Fellows & Liu, 2003). In this study the research design was decided with help from the suggestion that the research style is dependent on the formulation of the research question (Yin, 1994); see Table 1.

Table 1. Relevant situations for different research strategies(Yin, 1994)[3]

Strategy	Form of research question	Requires control of behavioural events	Focus on contemporary events
Experiment	how, why?	Yes	Yes
Survey	who, what, where, how many how much?	No	Yes
Archival analysis	who, what, where, how many how much?	No	Yes/No
History	how, why?	No	No
Case study	how, why?	No	Yes

All of the research questions in this study, apart from question two that is a 'how' question, are formulated as 'what' questions. According to Yin's theory illustrated in Table 1, the best way to answer these questions would be with a survey.

The method chosen for this research is an interview survey, with influences from the case study strategy. The choice of an interview survey and ending up with qualitative data is a strategic choice. Common knowledge about risk management and its terminology is limited at construction projects, especially at site level. To avoid any misinterpretations, having a dialog about risk management issues rather than filling in inquiries has been important. By using the semi-structured open-ended interviews, the respondents were free to add additional information and the researcher was free to adjust the interview questions for each situation and over time.

To answer the research questions through interviews, the interview questions are key to success. The process to develop the right interview questions is described in Figure 7 where the major inputs to the interview questions come from three areas, viz. research questions, theoretical framework and theories of research methods, and the applied

[3] SOURCE: COSMOS Corporation

method. The background and delimitations for the thesis also give certain guidelines for both the research and interview questions. The format and function of the interview questions then set the scene for the interview, as does the overall context for the interviews, such as the number of interviews, selection of projects involved and selection of key individuals to interview.

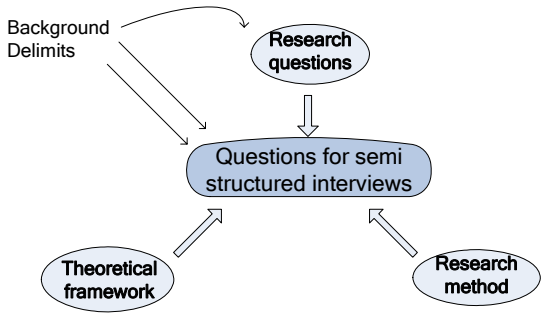

Figure 7. The basis for formulating the interview questions.

To test the interview question and the form of the interview, a pre-study consisting of nine interviews was made. This pre-study included only site managers and the questions focused on which risks they actually felt were the most common in small projects. The site managers in the pre-study represented the large construction companies NCC and Skanska, situated in Luleå. The results from this pre-study were presented at CIB 2005 Helsinki Symposium (Berggren[4], 2005). During the pre-study interviews, it became clear that the theoretical terminology had to be reformulated into more a applied and situation related language. The interview questions in the main study were prepared with this knowledge in mind.

In each project it was important to find information about risk management processes as well as reveal information about the project context and the individuals. Information concerning the risk management process detailed questions about 'what, how and who' was important, see Figure 8. The project and individual information was received through direct questions, where the respondents answered open-ended questions. The information from these questions depended highly on the respondents' willingness and motivation to talk about themselves. The information about obstacles and drivers from the first interviews was received through indirect questions and 'reading between the lines'. This did not produce as sharp results as desired and the consequence was that complementary questions were added in the following interviews.

[4] Researchers maiden name, changed to Simu, July 2005

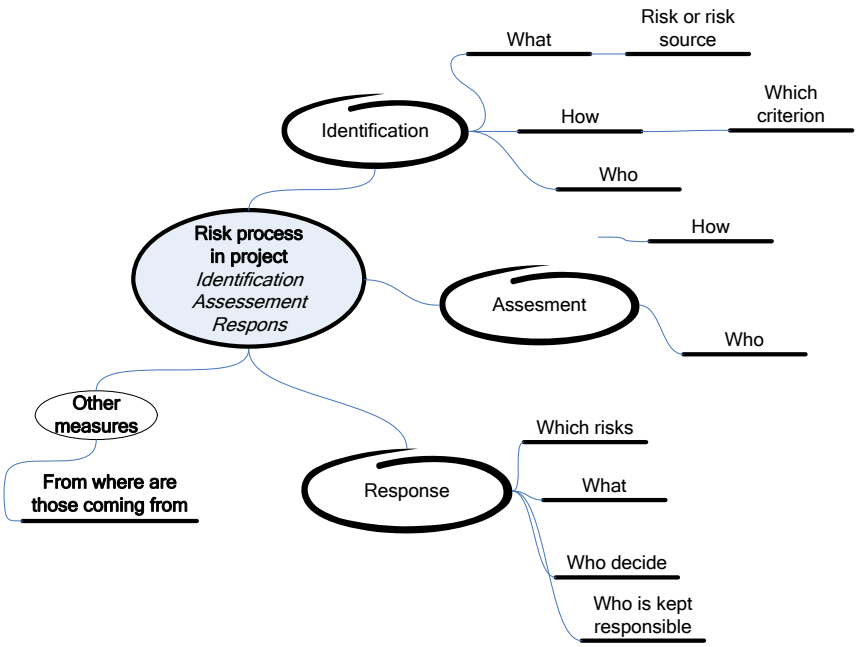

Figure 8. Risk management approach at site level

2.4 Selections within the study

This study focuses on the site level of construction projects. To ascertain where the information about risk management in these projects is kept, discussions were held with the reference people[5] of this study. In accordance with the theories, the best way to get information was to talk with those involved in the projects. Triangulation in research is all about finding multiple sources of evidence (Yin, 1994), and in this study, different sources of information were used to collect data, such as documents and interviews, see Figure 9. The interviews were held with three individuals having different roles in each project.

The key role individuals to be interviewed were to be the site manager, the project's manager from the construction company and the project manager from the client. As a complement to the interviews, some documentation about each project was studied. A chart of the basic information in the projects is shown in Figure 9.

[5] Group of reference is made up of representatives from Construction related industry in Sweden

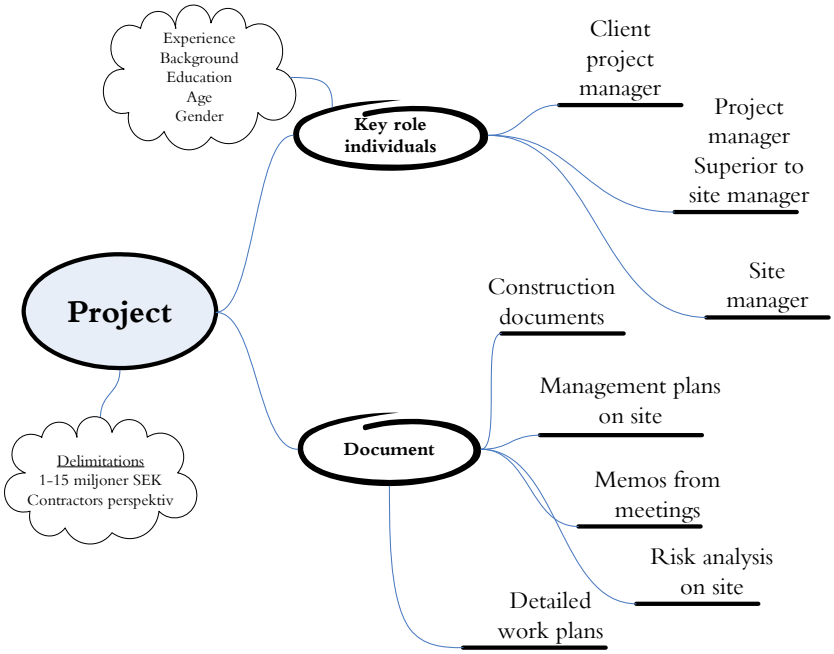

Figure 9. Chart over where the interesting information in the project is kept.

It was decided that a sufficient number of projects would be about ten, since ten would be enough to achieve information saturation but still few enough to collect the sought information through interviews and document studies. Data collection would thus be based on approximately 30 interviews. At the end, 28 interviews were made, since two of the project managers were responsible for two projects each.

The approach for the study was to get information having the construction project in focus. The selection of projects was made from construction company contacts in eight of the projects and from client contacts in two of the projects.
Three of the companies act on a national market, i.e. NCC, Skanska and Vägverket Produktion. The other companies act locally to regionally, where Nåiden and GLB are in Norrbotten and act in a small town market. SH Bygg and Friijo entreprenad are in Stockholm/Uppsala and act on a more urban market. The selection of the ten projects was based on a spread of geography, size of construction company and urban/rural area. The chosen projects and the selection of companies represent the Swedish construction sector fairly well. The ambition was not to have any conclusions regarding differences in market situation, geography or company size, but merely to find a good representative

selection. The aim was to have two projects from each participating construction company. No particular type of project was chosen and the overrepresentation on groundwork and refurbishment work is explained by the size limits of 15 MSEK in the projects. Hardly any new production of housing or civil engineering is 15 MSEK or less.

Table 2. Type of project related to contractual form and extent of activities

Type of project	**Contractual form**	**Extent of activity**
New construction	GE[6]	Foundation work and concrete construction of building for electricity distribution
ROT[7]	GE	New construction of computer hall and refurbishment of office building
ROT	GE	Refurbishment on residential buildings where the same contractor had done the first part the year before.
ROT	GE	Installation of new ventilation and electricity in an institutional building and refurbishment on roofs and floors.
ROT	GE	Refurbishment of office building with installation of cooling plant and system.
Ground work	TE[8]	Foundation work and landscaping at housing project.
Ground work	GE	Refurbishment on district heating system in city street.
Ground work	GE	Reparation of pavement, culverts and small works to the road zone.
Ground work	GE	Recycling and reparation of pavement and small works to the road zone.
Ground work	GE	Refurbishments of canal with groundwork close to and in water and some construction work at canal sides.

Contacts were taken with the two major construction companies in Sweden, Skanska and NCC, and with local companies in Luleå, Stockholm and Uppsala. Skanska represented the large company in Luleå and NCC in Stockholm, to minimize any bias from the fact that NCC in Luleå employs the researcher. The reason to only choose one project from each large company is the assumption that their systems and methods for dealing with risks are similar. This assumption was made from the interviews in the pre-study with Skanska and NCC in Luleå.

There were difficulties to get local construction companies in Luleå to take part in the interviews. Three of the five companies contacted declined to participate due to not

[6] GE, General contract

[7] ROT, Repair, alteration and extension

[8] TE, Build and Design contract

having the time, pressed circumstances amongst personnel and lack of interest from staff at site level. However, all the companies that were contacted declared an interest in the risk management area, even though they rejected further engagement after weeks of thought. Due to the difficulties in finding an appropriate project that fitted the project size limitations of less than 15 MSEK (roughly 1,5 MEuro), an additional two companies participated with only one project each.

Interviews were conducted as meetings with the exception of two interviews where videoconferencing equipment was used instead. The time varied between 35 to 90 minutes, depending on how much information and how talkative each respondent was.

The transcripts of the interviews were made in two steps. During the interview the dialog was recorded and the researcher focused on the dialog and the respondent. After the interview the researcher listened to the interview and made a transcript of the answers to the interview questions and other issues relevant to the research topic. The interview was not transcribed word for word, but only the essence according to the researcher. The transcripts were then typed out and sent to the respondents for proofreading.

To sort and handle the information collected in the interviews the software program N5 was used. N5 analyses qualitative data, making it possible to be handled systematically (Robson, 2002). The transcripts from the interviews were transformed as plain text documents and imported into the N5 database. The coding occurred in two different approaches, one tree node structure following the general information about the projects and the other tree node structure following the research questions. Additional free nodes have been coded, since they related to interesting information not obviously connected to any of the tree node structures. N5 has been used as a tool to sort information in different categories and see patterns related to the research questions. There has been no use of text searches, but only reports on information that is coded at the different nodes.

The analyses are done in two different approaches. The first step was a deductive approach where the results were compared to the theoretical framework. As the results from the interviews gave more information than merely the answers to the interview questions, these results were also disclosed in the analyses in Chapter 4. The headings for those sections in Chapter 4 have been developed through an inductive approach.

2.5 The trustworthiness of this thesis

Validity in research is how well the results match the aim of the study. How well the target is hit. Did the results of the study answer the research questions? Reliability is about how reliable the results of the study are and refers to if the study is replicated. Validity and reliability are all about how trustworthy a research study is.

In this study multiple sources of evidence were used, i.e. interviews, documentary studies and researchers background knowledge. The model for analysis was built up by using the theoretical framework and the definitions made there. The analysis model is then taken to the next step, where the interview questions are formulated and then back to the presentation of the interview results. The final step to close the research question loop is done in the final chapter of conclusions. Other studies have also been used to compare the theoretical framework and results. This comparison shows that other researchers chose the same framework for studies within construction projects. The conclusion for this study is that the chosen theoretical framework is well established and the right one. The results from previous studies were made through quantitative methods and have focused on other organisational levels. Despite this, the results are comparable, thereby ensuring that the results in this study are trustworthy.

3 Theoretical framework

This chapter presents the theoretical framework used in this thesis. The definitions of risk and risk management process used in this thesis are described as well as previous research in the field of risk management in construction. The definitions are used to set the scene and background for the collection of empirical data. Previous research is used as a reference to similar results but in different contexts. The aims of this chapter are to;

- *define the risk definition used in this thesis*
- *define the risk process used in this thesis and how it is merged from presented theories*
- *give a brief presentation of risk perception and usage of risk management in construction found in previous research*

3.1 Risk and uncertainty definition

Since there are many different definitions on 'risk' as well as 'uncertainty' this section aims to give a theoretical overview as well as pinpointing the definition used in this thesis, Figure 10.

Project risk is defined as a "combination of probability of an event occurring and its consequences for project objectives", according to the international standard IEC 62198:2001. This is a rather technical definition of a matter that is quite individual and also somewhat philosophical. To set the scene for the risk definition chosen in this thesis the different approaches to risk and uncertainty is presented.

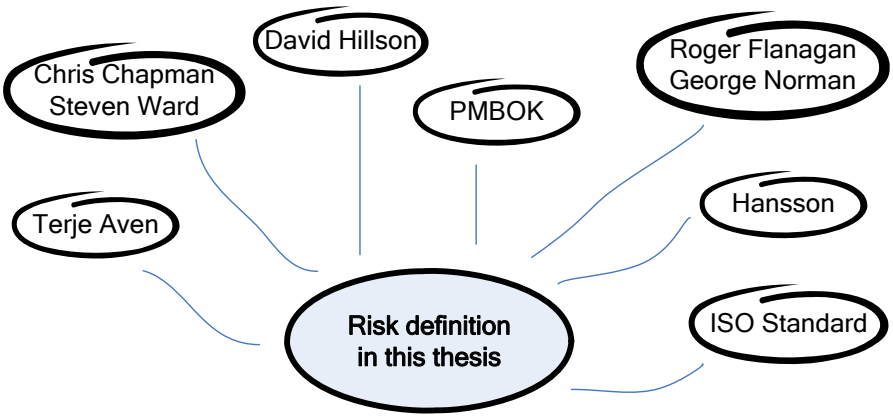

Figure 10. There are many different sources for definitions and descriptions on the terms risk and uncertainty.

Uncertainty is part of everyday life, since we are unable to accurately predict the future. The amount of uncertainty and how we can handle this uncertainty could, however, be defined and structured. Risk is closely connected to uncertainty and is a commonly used term in all kinds of contexts, but is often related to the negative outcome of a certain event. There is a trend towards the usage of uncertainty instead of risk, since it is

regarded as more appropriate for the means of the work to be done (Ward & Chapman, 2003). Ward and Chapman state that there is a need for a clearer focus on the upside effects, i.e. the opportunities. They believe that it is desirable to let go of the close connections to historical events, conditions and sets of circumstances and instead focus on the different sources of uncertainty that could lead to threats of failure or, equally, opportunities. Instead of closely connecting specific objectives of the risks and uncertainties involved, they suggest that uncertainty management is about anything that matters for the project success. It could then be objectives but also the perception of risk and uncertainty that are given in a project. Their opinion is that it is vital to understand where and why uncertainty is important in a given project context and to not focus solely on the threats and opportunities connected to given events, conditions or circumstances. They continue their line of argument with the suggestion that `uncertainty management´ should replace `traditional risk management´ to indicate that a wider perspective is being sought. It is also important to realise that the key issues help to understand where and why uncertainty plays an important role in a specific project and its context. Regardless of this development in the field the term risk has been preferred in this thesis because it is more established in both theory and practical use. The term uncertainty was tested in the pre-study interviews and its usage instead of risk confused the respondents. Nevertheless, further definitions between the two concepts are needed before leaving the subject.

According to the Project Management Institute, PMI (PMBOK, 2000), a definition of risk should consider both the positive and negative effects of a project objective. This is a broad view in terms of threats and opportunities and how they are connected to an event, a condition or a specific circumstance. This is the definition that works in theory but fails in practice. Despite the enlightened definition, opportunity is neglected when it comes to practical use. According to PMI, risk includes upside effects, the opportunities, but tradition focuses on the downside, i.e. the negative effects.

Risk and uncertainty could also be described in a more theoretical sense. They could be addressed as either aleatory or epistemic. An aleatory risk is a risk that could be regarded as random, estimated with probabilities and consequences to a set of possible known outcomes, but still, in the end, with a random outcome. To get a better understanding one can view this as something made in the right way, in the right system, but with the wrong outcome because the outcome is random and not predictable. An epistemic risk or uncertainty is more related to a lack of knowledge about matters having an influence on the outcome. These uncertainties are more about lacking the essential knowledge or using the wrong methods and tools to identify or assess risks and uncertainties. It could also be that there is a lack of information to identify or assess. An epistemic `uncertainty´ is thus an "unknown event from an unknown set of possible outcomes" (Hillson, 2004). This way of describing epistemic uncertainty leaves the door open for an interpretation

that uncertainty is prior to risk in some sort of logical process, Figure 11. Hence, the concept of uncertainty could lead to opportunities as well as risks.

This way of regarding risk is also found in the book 'Risk Management in Construction' (Flanagan & Norman, 1993) and in the philosophical view of decision theory (Hansson, 1994). Risk is somewhat calculable in their view, since it has to do with probabilities, whereas uncertainty has no previous history to relate any probabilities to. Uncertainty is rather an epistemic uncertainty, since it has to do with uncertainty of outcome and related to system performance (Aven, 2003).

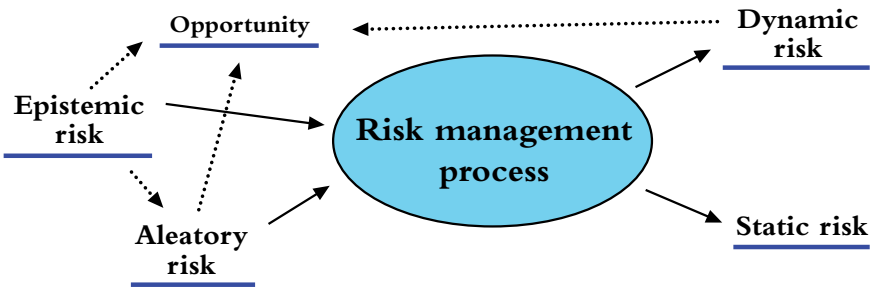

Figure 11. Epistemic uncertainty, aleatory risk, opportunity, dynamic and static risk and their relation to the risk management process in a time logical sense.

Risk and uncertainties are handled everyday on a construction project, but not all are of the type that needs special attention. A dynamic risk is a risk where there is a possibility to gain something at the end, whereas a static risk is only associated with losses in some way (Flanagan & Norman, 1993). Both types of risks could call for special attention depending on the project context and relate to concrete risks sorted to their outcome, the effect of the risk. However, the epistemic and aleatory risk addresses risk and uncertainty in a theoretical perspective. They are important during the early stages of the process, since they emphasise the difference between risk and uncertainty, see Figure 11 and Table 3. According to this interpretation, it is possible, but not necessary, to start with high degree of epistemic uncertainty that develops into aleatory risk as knowledge about the world increases. With a high degree of background knowledge the amount of epistemic uncertainty decreases, and knowledge about the quantities of probability and consequence is the only part remaining uncertain. It is, however, essential that project managers are aware of both epistemic uncertainty and aleatory risk because both could greatly impact the project outcome and call for different management approaches.

Table 3. The relations between uncertainty, risk, and opportunity

<table>
<tr><td colspan="2">Uncertainty

An overarching term that could have two possible outcomes, a risk or an opportunity</td></tr>
<tr><td>Epistemic risk and uncertainty

Lack of knowledge about possible outcomes. Lack of knowledge about what you do not know.

Example: lack of knowledge about that you should consider ground pollution when acquisitioning property.</td><td>Dynamic risk

Is a risk where there could be both a positive and a negative outcome.

Examples are fluctuations of prices on material, technical solutions, weather

Example: Ground pollution where you have a good solution for solving such problems, but are unsure if it works in this specific environment.</td></tr>
<tr><td>Aleatory risk

Random risk, possible set of outcomes is known, but how much consequence and probability are not known even though they are calculable.

Example: Knowledge about the risk of ground pollution, but uncertain regarding the possibilities and consequences for such an event.</td><td>Static risk

Or ‘pure risk’ and is related to losses and negative outcome of an event. Examples are damage, injuries and losses.

Example: Ground pollution of such a character that it severely threatens to pollute the groundwater or be hazardous to workers on site when dealt with, regardless of method used.</td></tr>
<tr><td>Opportunity

Uncertainty with positive effects

Example: Ground pollution where you have a unique and good solution for solving such problems.</td><td></td></tr>
</table>

In this study uncertainty is used to point out the possibilities for both ‘risks’ with the negative effects and ‘opportunities’ with the positive effects. The definition of risk used here focuses on the negative outcome of an uncertainty.

Risk is defined as something that occurs and which is foreseen neither in the project description nor in the contract, often being caused by lack of knowledge of one or many of the parties involved. These risks could be dynamic or static, aleatory or epistemic, and could be an event that occurs during the project. It could also be something known from the beginning that makes the project unique, i.e. makes it different from the standard procedure. This definition is well in line with results from a questionnaire study in the UK carried out by Akintoye and MacLeod (Akintoye & MacLeod, 1997). They found that general contractors' perception of risk is closely connected to the objectives of the projects in terms of cost, time and quality.

3.2 Risk Management systems

Risk management systems are used in companies and organisations to ensure the control of risks in the business process. In this thesis the simplest possible approach to describe the risk management process is chosen due to the context of the construction sector.

Risk management systems literature has different ways to relate to the risk management process. There is no common definition on the scope of risk analysis, risk management or the risk process in the literature, since each one has its own twist (C. Chapman & Ward, 2003; Flanagan & Norman, 1993; IEC62198:2001, 2001; Ingvarsson & Roos, 2003; Smith *et al.*, 1999). It is therefore essential to describe how the risk management process is chosen to be presented in this thesis.

The risk management process in its simplest approach has been chosen. The risk process consists of the risk analysis followed by the risk response. Risk analysis refers to the inclusion of identification and assessment, see Figure 12.

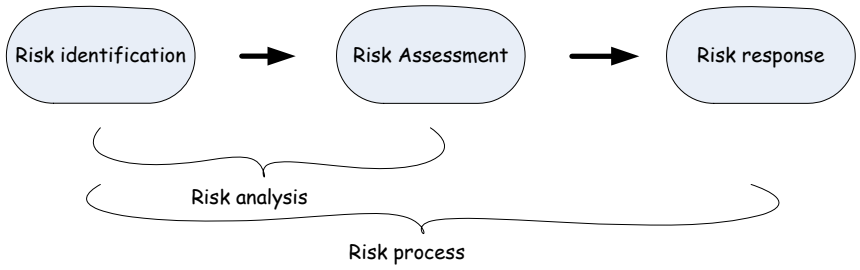

Figure 12. The simplest approach to risk management system.

3.2.1 Risk identification

This step has the least systems and tools related to it. Still, it may be the most important and time-consuming step in the above process. In the literature, the identification step has received the least attention, and the tools and techniques to increase the effectiveness has focused on risk register, RBS (risk breakdown structure) and brainstorming (Maytorena, 2005). The consequences of incorrectly identifying risks are that when these risks are considered in the management system, incorrect assessments and responses will follow.

The SHAMPU[9] model introduced by Chapman and Ward (C. Chapman & Ward, 2003) emphasizes the importance of correctly and extensively identifying risks and uncertainties, aleatory as well as epistemic. They do not restrict themselves to risk events, but include all sources of uncertainty and associated responses. This is a very thorough approach that includes many steps regarding risks and uncertainties related to *who, why, what, which way, wherewithal, when* and the *Project Life Cycle*. By using a model that includes all of these factors, the threat of missing risks along the way becomes minimal or is at least decreased. The disadvantage of using such an extensive approach is the threat of loosing users on the way. For this research project the SHAMPU model was too theoretical and extensive to apply on site or even to compare with what is done on site according to the results in the pre-study and of the previous experiences of the researcher.

In the process of identifying risks in a project, it is necessary to consider the different sources of risks present in the project and the different classifications of risks that could be of current interest. It is also important that there is a clear distinction between the risk source and a risk effect (Flanagan & Norman, 1993).

3.2.2 Risk assessment

Risk assessment is done in numerous ways. There are tools and techniques that have been developed to consider probabilities and consequences, using either historical data, statistical data or estimated judgement translated to numerical information (Aven, 2003; Grey, 1995). There are also judgments grading certainty in rare-almost certain and low-extreme. Common are the estimation of probability and consequence and the usage of software tools to manage the data. This thesis will not give an extensive presentation of the various tools and techniques for risk assessment, only a brief overview and some references for further reading.
Scoring techniques (Grey, 1995) are developed checklists that include the judgement of both probability and consequence of a risk breakdown. This is a common technique for risk assessment in construction projects that is widely used due to its simple approach.

[9]Shape Harness And Manage Project Uncertainty, SHAMPU

The disadvantage with this is, as with checklists, that matters become forgotten. The bias that also needs to be considered is that different judgement will appear depending on the individuals carrying out the assessment.

Using models or simulation to assess risks is another way to proceed. Models are simply a breakdown of a complex project into manageable bits and pieces, often by using mathematics to show how these bits and pieces are linked together. The disadvantage with any model using figures is that they could easily blend the user with exact figures, without having more precise information than a more qualitative answer. It is important to be aware that with models and simulations, the saying that 'what goes in is what comes out' is very applicable.

3.2.3 Risk response

In the risk response step the action is taken to control the risks analysed in the first two steps. In this thesis the response step covers both the planned response and the monitoring of the responses. Responses is often graded in four levels, namely risk retention, risk reduction, risk transfer and risk avoidance (Flanagan & Norman, 1993).

Risk retention concerns accepting the presence of risk and still conducting business as usual. The reasons for retaining the risk could be that the estimated probability, consequence or the combination of the two is low and at an acceptable level. A good everyday life example is when it comes to the choice of insurance premium. Either one takes a high premium and then gets reduced excess or chooses a lower premium and gets a higher excess. Still, the risk is there and retained.

Risk reduction is about decreasing the probability, the consequences or a combination thereof for a risk to breakout. This could be done in several ways, of which sharing with other parties or taking some action where the probabilities or consequences become reduced is common. One action to reduce risks is through educational training of personnel to increase the awareness about possible risks and to make people think in terms of 'what if'. Having personnel with this way of thinking decreases the disadvantages of shortcomings in supporting system. Checklists and different types of scoring techniques can be used as support without the risk of being in too much control. Other actions can be to physically reduce the risk by building systems, rails to eliminate falls, sprinklers to eliminate fire and so on. There could also be involvement of a third party as an extra assurance and quality control of projects to ensure that nothing is forgotten or overlooked. A common way to reduce risks at construction sites is through work planning. The work plans consist of timetables and allocation of resources such as staff and equipment.

Transferring the risk to another party is a fairly common way to deal with risks in the construction sector. It is transferred from the client to the contractor through the agreements in the contract, or from the contractor to the sub-contractor. In the Swedish construction sector, general contracts are less risky for the contractor, since the client is

held responsible for the building documents according to Allmänna bestämmelser, AB[10]. In Design and Build contracts, great risk is on the contractor, since they take the full responsibility for both the design and construction.
Another way to transfer the risk is to have insurance, which is a way to transfer the uncertain cost for a potential loss to a certain cost of money for the premium.
Risk avoidance is about refusing to accept a risk. This is either done by simply refusing a project that is too risky to proceed with or by writing exceptional clauses in the tender.

3.3 Risk perception in construction

Previous researches in the field of risk management and the perception of risk in construction have established common risks and risk sources for projects. This section will briefly describe the risks and risk sources as well as similar research in construction.

Risk perception is an individual judgement based on a person's beliefs and attitudes. Risk perception cannot be reduced to mathematical models using probabilities and consequences (Risk: analysis, 1992). In many of the earlier described definitions in this thesis, probabilities and consequences are used and applied in literature. However, the practical branch of construction does not correlate to this theoretical approach. In a questionnaire survey in the UK (Akintoye & MacLeod, 1997), the perception of risk was closely connected to the objectives of the projects, time, cost and quality. Their perception of risk was the occurrence of something unforeseen that would have adversely affected the successful completion of the project. The connection to probability and consequence is concealed and other matters settle the perception of risk.

In another study, the relation to knowledge management is highlighted as a means to get beyond the traditional approach with its logical structure based on identification, assessment and response. The motivation for this is the conclusion that the traditional way to manage risks does not give the sought after results in construction projects (Tah & Carr, 2001).

[10] Allmänna bestämmelser, AB, is the general agreements for contractors and clients.

The attitudes and usage of risk management systems in construction have been examined frequently from 1987 to 2004 (Lyons & Skitmore, 2004; Mills, 2001). Lyons and Skitmore have used four surveys from various papers between 1994 and 2001 (Akintoye & MacLeod, 1997; Baker *et al.*, 1999; Raz & Michael, 2001; Uher & Toakley, 1999), when conducting their survey in the Queensland engineering construction industry 2002. Lyons and Skitmore compared the different surveys and made some conclusions about the usage and development of risk management in construction;

- Risk management usage in the execution and planning stages of the project life cycle is higher than in the conceptual or termination phase. This contrasts with the view that application of risk management in the conceptual phase is the most important.
- Risk identification and risk assessment are the most often used risk management elements, ahead of risk response and risk documentation
- Brainstorming is the most common risk identification technique used. Consistent with previous survey findings, intuition/judgement/experience are the most frequently used assessment techniques. That no single risk assessment technique is best for all cases may in part be why the respondents have opted for the simplest approach.
- Qualitative methods of risk assessment are used most frequently, ahead of quantitative and semi-quantitative methods.
- Project teams are the most frequent group to be used for risk analysis, ahead of in-house specialists and consultants. The level of training in risk management techniques is low to moderate.

These conclusions are from a survey sample covering senior managers in the Queensland construction industry comprising owners, property developers, consultants and contractors. The response rate was all in all 22% and for the group of contractors almost 18%.

Mills emphasises the importance of having a systematic approach to risk management early in the construction process, by the developers and designers (Mills, 2001).

There seems to be a low usage of formal risk management techniques in construction due to several reasons. For the clients, there could be lack of familiarity with the techniques for risk analysis and risk management or the view that project risk management is about people and not scientific models (Akintoye & MacLeod, 1997). For the construction sector as such, the reasons were similar with the following additions;

- lack of time and knowledge about risk management
- doubts weather available techniques are applicable to the construction industry
- risks are closely related to the contract and the construction of a project and are therefore best dealt with assessments based on experience from previous projects
- most projects are too small to use formal risk management on site (Akintoye & MacLeod, 1997; Lyons & Skitmore, 2004).

Risk identification in construction has traditionally been done by either checklists, brainstorming or interviews, thus relying on the individual's personal experience, knowledge and individual judgements (Akintoye & MacLeod, 1997; Al-Tabtabai & Diekmann, 1992; R. J. Chapman, 2001). According to Maytorena (Maytorena, 2005), these are not the key issues to effective risk identification. She states that experience appears to contribute less to effective risk identification than educational background. The differing opinions show that the process step of risk identification is far from fully known to the world of researchers. This study has collected data regarding educational background and practical experience, though the focus has been to neither support nor falsify other researchers' theories in the field.

In a recent masters thesis, the difficulties for a project management group to clear distinguish between risk source, risk event, risk effect and risk response is highlighted (Edeblom, 2006). The results show the difficulties of having an open mind in the identification stage and the difficulties to not jump to any conclusions and focus on the problem solving immediately. This difficulty is also found in a comparison between risk management in theory with practice. A result from this study is that there is confusion in the risk identification phase concerning the events, causes and consequences for risk (Baccarini, 2001).

Another important contribution from previous research is the conclusion that the return of experience is poor. In a study focusing on the failure cost in large civil works projects, one conclusion is that 60% of the costs are due to inflicted uncertainty and therefore could have been avoided or reduced with a better return of experiences (Nylén, 1999).

4 Results and analysis

This chapter presents and analyses the results from the field studies. There were 28 interviews, comprising 9 interviews with clients and 19 interviews with contractors. The pre–study comprised 9 interviews with site managers from two different construction companies. Results from the pre-study are found in the appendix.

The aim of this chapter is to describe risk management from the respondents' viewpoint and analyze their responses in relation to the theoretical framework described in this thesis.

From the chosen limitations mentioned earlier, 10 projects from different construction companies were selected. The companies have different sizes and different geographic locations. Key role individuals for the interviews were site managers, their closest superior, the project manager and the client's project manager. The similarities between organisations have made it easy to find the "key role" individuals in each organisation. In two cases one individual responded for two projects, and hence the number of interviews stopped at 28.

4.1 The companies involved

The projects in this study have been selected with the ambition to have representation from small as well as large construction companies and from urban as well as more rural geographic areas.

In this study, seven different construction companies and eight different client organisations have been involved, i.e. NCC Construction Sweden AB and Frijo Entreprenad AB from Stockholm, SH-bygg from Uppsala, Vägverket Produktion from the region of Västerbotten, and Skanska Sweden, Nåiden och GLB from the region of Norrbotten. The clients were companies and organisations connected to the projects at their different geographic locations. Further details about participating companies are in the appendix.

4.2 The projects involved

The projects in this study were selected from the delimitations presented in Chapter 1. To get a better understanding of the results this section aims to describe the projects and their contexts.

The projects in this study are spread geographically from Stockholm in the south to Luleå in the north, all on general contracts except one build and design contract. The form of the contract was not a prerequisite, it just happened this way, probably because small projects are more often on the general contract form.

Project 1
This project consists of refurbishment on blocks of flats where the contractor with the same site manager has done the same work at other blocks for the same client the year before. The project size was about 12 MSEK and the construction time approximately 6 months. Many different craftsmen and subcontractors have been on site. The focus for the contractor has been first and foremost economy, then quality and finally time. For the client the priority was quality then economy; time was not mentioned.

Project 2
This project was groundwork where pipes for central heating were exchanged on a busy city street. The client and the contractor have worked together many times before. The project size was about 1.7 MSEK and was on general contract. Apart from the main contractor, two subcontractors were involved. The focus has been on economy according to the contractors, and quality of function and time according to the client.

Project 3
This project included blasting and groundwork for building foundations as well as landscaping surrounding the buildings. The contractor and the client had never before worked together, and the whole experience was new. The contractor in this study is a subcontractor in the main project; hence, the client is normally the contractor. The project size was about 5 MSEK and is a design and build contract with very strict limitations regarding the construction parts of the contract on a general contract form. Focuses of the project are, according to contractor and client, time and money.

Project 4
This project was about refurbishment in an institutional building, where new ventilation and electricity was installed, along with work on the roofs and floors. There was a special construction time with few hours spent over a long period, 1.5 years. The site managers also had other projects ongoing during the same period. The projects size was 11.4 MSEK. The focus according to the client and the site manger was the economy, and the contractor's project managers had time as their main focus. The contractor had not worked with the clients' project manager before.

Project 5
This project was about the new construction and refurbishment of an office building. The client and the site manger had previously worked together and knew each other's way of working. The project size was 13.5 MSEK and the construction time was 10 months. There were seven subcontractors involved in the projects. The site manager do not run more than one project a time, apart from the overlapping between projects. According to the site manager the focus has been in the following order, i.e. economy, quality and then time. According to the contractor's project manager, it has not been possible to prioritise between economy, quality and time. According to the client the main focus is on the quality of this project, with time not being an issue.

Project 6
This project was groundwork on road sides where reparations on culverts and minor work to the roadside were done. The project size was between 5-7 MSEK and the construction time was 4 months on a general contract. The main focus according to the contractor's project manager is the economy, followed by quality and then time; this prioritising is shared with the client. The site manager focuses on quality and then time. The contractor and client have much experience from working together.

Project 7
This project was refurbishments of an office building while business continued as usual inside. New windows and a new cooling plant and system were installed. The project size was about 4 MSEK. In this project the main focus has been quality and then economy, with time being the least important; this view is shared amongst the client and contractor. In this project a consultant has represented the client to some extent and the role of the client in relation to the owner of the building has been unclear.

Project 8
In this project, the client hired consultants for the project management, with whom the contractor had worked before. The project size was 5 MSEK and the construction time was 4 months. The work to be done included groundwork and the new construction of a power station for electricity distribution. According to the client, time was tight in this project and thus in focus, whereas according to the site manager it was not possible to prioritise any of the three parameters. According to the contractor's project manager, the economy was the main focus.

Project 9

This project included groundwork in the form of reparation and extending the roadsides. The project size was about 4.5 MSEK and the construction time about 4 months. The site manager had two other projects running at the same time, totalling three projects, with some extra help from other site foremen. The contractor's project manager has focused on the quality of the project, while the site manager has had difficulties prioritising between economy, time and quality, since all are equally important. According to the client, economy and quality have been the focus in this project. The client and the contractor have much experience from working together.

Project 10

This project consisted of groundwork with lots of finishing details. The site manager had one other project to finish along with this project. The project size has been about 2 MSEK and the construction time about 4 months, on a general contract. There is a shared view that quality has been in focus, though the respondents have been split between prioritising amongst economy and time. This prioritising has affected to the tendering procedure, according to the client.

4.3 Key role individuals

Three individuals were interviewed in each project, i.e. the site manager, project manager/production manager from the contractor and project manager from the client. The respondents have different experience and background; still, it is a rather homogenous group. The aim in this section is to present this group of individuals and their experiences and educational background.

The individuals involved in the study have been categorized in different groups depending on their approach to risk management and quality management systems. Figure 13 shows a chart where each individual is represented with one dot. The individuals are also grouped in their respective project, separated with the vertical lines in the chart.

The years of experience are spread, as shown in Figure 13, and a pattern of two groups is visualized. One group has extensive experience with more than 20 years, whereas the other group is less experienced with 3-12 years in the business. Individuals with experience between 12 and 22 years are missing. Most respondents also 'joined' the construction sector at the start of their working life and then stayed. Reliance on experience is also heavy from the respondents' point of view. One of the respondents started the interview with these words:

> *"I have worked in this sector for a very long time…."*
>
> *(Clients project manager in project 2)*

The respondents' educational background is described as follows: vocational training 4 (of 28), engineers[11] 14 (28), bachelors of engineering[12] 3 (28) and masters of engineering 7 (28). The respondents with the least years of experience all have higher academic education than average, 7 out of 10 with academic education have less than 10 years of experience.

Amongst the interviewees, four different groups relating to the way they control the project were identified. These groups are: the 'doers', the 'system users', the 'wannabees' and the 'frustrated'. The naming of those groups has merely been chosen from the head of the researcher with no connections to other theories or fields of research. The 'doers' are persons down to earth at the project site. They control their project in a traditional way, where the reliance to timetables and a budget is high, Figure 14. This group is overrepresented by individuals with much experience and a lack of higher academic

[11] Gymnasieingenjör eller motsvarande

[12] Högskoleingenjör 80-120p

education. The 'system users' refer to a group of individuals who use provided management systems that include risk management[13] and see the benefits from using the systems. These individuals are spread between the groups of experience, but are overrepresented amongst the individuals with higher academic education. The group of 'wanna bes' is individuals who see the benefits and feel the need of a management system that includes risk management, but do not have a system today. They work like the 'doers' but want to move their way of working towards the 'system users'. The last group identified are the 'frustrated'. They work both as the 'doers' and as the 'system users', but are very frustrated doing so. They do not feel the benefits from using the system, though they can understand it in a rational and logical sense. They struggle with demands from the system, while running the project as the 'doers' do. The individuals marked with a circle have a higher education, i.e. bachelor or masters of engineering.

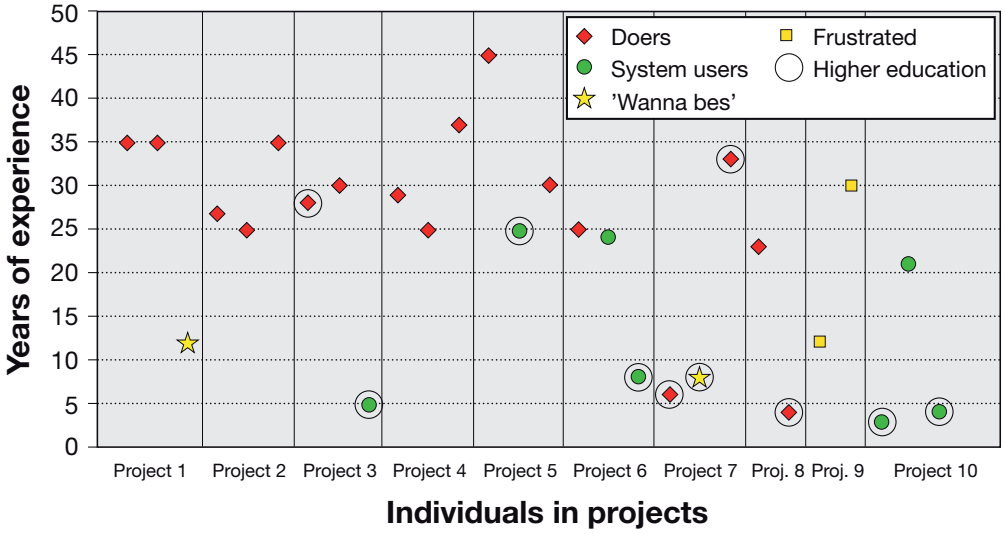

Figure 13. Individuals in the projects sorted in different groups related to their way of controlling the projects.

[13] Risk management (RM) systems in the theoretical sense are only slightly used in these projects. No individuals have training or education in risk management, only RM as part in other management systems.

The group of 'doers' is especially interesting, since they represent such a large proportion of the total group and their way of controlling the projects could be found in the other groups as well. In some sense, this is the traditional way to control projects in construction. The controlling process starts with the unstructured allocation of risk money in the tender. The money is allocated with a 'gut-feeling' rather than systematically. Controlling the project continues with the high reliance on timetables that are based on resources and activities. Quality surveillance is where the quality of critical events is documented, if documented. The background for this comes from the legal document PBL[14] and judgments from the site manager and the project managers. A common way to control issues in the quality surveillance plan is to do detailed work plans, either verbal or documented. Finally, controlling the project is done through building meetings where time, money and contractual regulations are handled. These steps are found in most of the projects involved in this study. The steps, however, are not necessarily kept together, and the system is lacking.

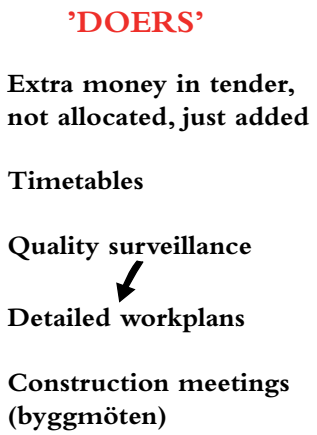

Figure 14. Schematic description of how the group of 'doers' manage construction projects

[14] Planning and building regulations, Plan och bygglagen, PBL

In the group of site managers, the 'doers' are overrepresented with 7 out of 10 being in this group, Figure 15. The mean years of experience in this group is 23 and in absolute numbers represents 3 (of 10) individuals with less than 12 years of experience.

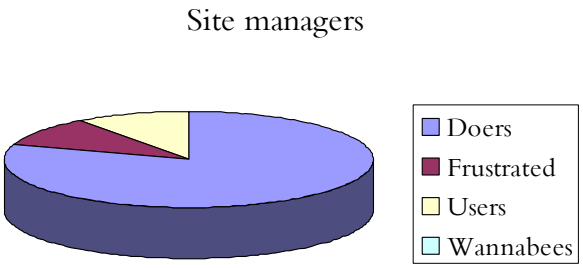

Figure 15. The category of 'doers' are overrepresented amongst the site mangers.

"With knowledge about the risks and uncertainties we find during the tendering process, we put in some extra money in the tender."

(Site manager project 1)

"This job is such an easy job, same thing over and over again. In other projects we start with the quality surveillance plan to make sure that we are able to fulfill the requirements and then we do detailed work plans, often with direct reference to the building documents to minimize our risk of misinterpretations."

(Site manger project 1)

Those two citations illustrate how the site managers perceive their control of the projects. It is a rather straight forward and 'hands on' approach with reliance to timetables and detailed work plans.

In the group of contractors' project managers the chart differs slightly, Figure 16, with a few more system users and one 'wannabee'. The mean years of experience in this group is 25 and in absolute numbers there is one person with less than 22 years of experience. The citations from contractors' project managers following Figure 16 exemplify their approach to the management of their projects.

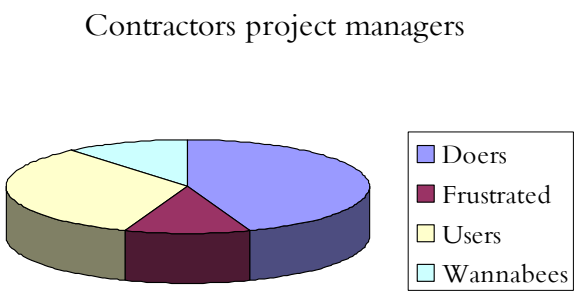

Figure 16. The spread of categories amongst the contractors project managers.

"To work with short timetables and detailed work plans, half of the job is then done. If you don't, you're always behind. If you have to work as a fire fighter, then I am sure that 90% of the decisions go wrong".

(Contractors Project manager in project 4)

"When we go through upcoming projects we discuss the risks that could come up. When free to discuss different viewpoints, we then decide, 'OK! Lets go for it' and we are aware of the risks involved and the risks we bring along throughout the tendering process, but we never document anything, the staff involved have such an experience. There is a culture of how to proceed even though it isn't managed through any documents. Those identified risks are included in the tendering process until we set the final tender, then we can cut it out."

(Contractors Project manager in project 1)

"In each project we find out what kind of quality surveillance we need in the project and that is actually to sort out the risks since we only do quality surveillance on things that could go wrong."

(Contractors project manager in project 7)

The group of 'doers' decreases amongst the clients, and apart from the obvious reason, they could be better system users, another reason could be that information about the clients' management system has not been in focus during the interviews. The mean years of experience are also lower in this group, 18.5 years of experience, representing in absolute numbers 5 (of 9) individuals with less than 12 years of experience.

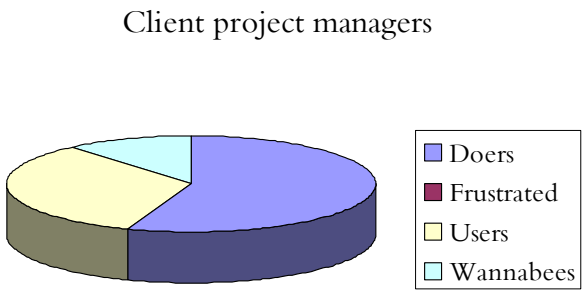

Figure 17. The spread of categories amongst the client project managers

Education or training in risk management is lacking amongst all of the respondents, though 13 (of 28) respond that they have been in contact with risk management through education and training in quality management systems. Of the 28 respondents, 15 do not have any training or education related to risk management.

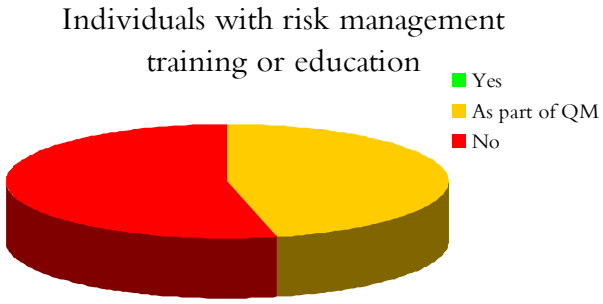

Figure 18. There is a lack of training and education within the field of risk management amongst the individuals in this study.

4.4 Results from the interviews

In this section, the responses from the interviews are sorted and presented. To make it easier for the reader, the answers are sorted according to the different groups interviewed, i.e. clients and contractors, as well as on the main issue, the risk management process. At the end of each section there is an analysis of the results compared to the theoretical framework.

4.4.1 Client representatives

The client representatives in this study, 9 (of 28), were the project managers working close to the construction site. In some cases, 3 (of 9), they have been consultants working as their representatives for the client.

Identification

For this part, the questions to the respondent focused on what is being done regarding risk identification, how is it done and by whom. To open up the minds of the respondents, the questions were frequently reformulated during the interviews. Instead of only asking about risks, questions regarding 'what makes you worried', 'are there any special hard events to be conducted' and 'what keeps you awake at night in this project' were put forward.

In some of those projects involved, 4(of 9), the clients have put demands on the contractor to manage risks. No one has, however, supplied contractors with requests of how or with any risks identified during the design process. The clients have relied on general construction documents according to AMA for their control of the project. A few clients, 2 (of 9), claim that they have done their own risk identification, but have not been able to point out specific risks during interviews or in documents supplied. There are rarely any risks that are identified as guiding to the contractor in the studied projects. One client is aware of the need for a more systematic approach from their horizon and said:

> *"We have requirements in our management system to manage project risks, but so far we have only stated that the contractors should do this. This is a new way of working and so far it has only been applied in one project and not in this one that we are talking about."*
>
> *(Client project manager in projects 6 & 9)*

Another client said almost the same thing about their way of handling project risks:

> *"We do require that the contractors have management systems for quality and environment but we do not have our own system in use as it is. We are working on the development of such systems."*
>
> *(Client project manager in project 10)*

In one project, a construction company represented the client and the contractor in this study was actually the subcontractor. This one project stands out as having the most systematic approach regarding risk analyses. A risk analyses was done at this project and the part affecting the subcontractor was put forward to him for further control.

In documents[15] supplied by the clients, there were rarely any opinions about whether the construction companies should do any special work plans for specific parts. Most clients, 8 (of 9), claimed that this was not any of their business to control the construction companies in such a way.

> *"We cannot put forward any demands on the contractor to do special work plans; it must be their responsibility to plan their job"*
>
> *(Client project manager in project 5)*

> *"There is no particular risk identification in this project; in new construction projects we do, but not in the refurbishment projects. (PAUSE)……You know, you really got me thinking now, I think I have to go back to my organization to tell them that we'd better start working in this direction."*
>
> *(Client project manager in project 1)*

In one project, the client who responded claimed that no risk identification or risk analyses had been done due to a lack of time.

> *"We have not made any risk identifications or risk assessments in this project, there has not been time"*
>
> *(Client project manager in project 4)*

However, when free to comment anything regarding risks, three relevant events were pointed out without any reflection that these were actually risks. These worries had not been pointed out from the client to the contractor, even though these events worried him and he obviously thought they could have negative effect on the project outcome. There had not been any attempts to control these events. Another risk pointed out in the project was related to a lack of control in the coordination of the design, which led to problems in the production stage. Still, nothing was done to control these problems, or rather risks.

[15] Construction/ building documents

In another project the client relied on his own knowledge and experience:

> *"I do my own checklist on things that could go wrong and follow it through the project. It is my own document in my own note pad. I do not follow any template, since all projects differ and have different prerequisites."*
>
> *(Client project manager in project 5)*

The client handles risks regarding the work environment to some extent, since this work is regulated in law. Risk management regarding the work environment is put forward as a demand for the contractor to handle on behalf of the client.

> *"Risks regarding the work environment are handled separate and the other risks are such a natural component of the building process: We do focus on those other risks, but because there are legal requirements regarding the work environment the handling of those are special."*
>
> *(Client project manager in project 10)*

Assessment

This part focuses on risk assessment and is highly dependent on the answers in the first part regarding risk identification. Questions have focused on how the identified risks have been assessed and by whom. Only 4 (of 9) clients have identified any risks that could be assessed theoretically.

Risk assessment is not done systematically according to the respondents' answers in the interviews, except for one project. Some of the respondents, 3 (of 9), recall some sort of risk assessment, whereas others, 4 (of 9), claim that nothing is actually done. It has, however, been hard to find any documents supporting those who claim that something has been done.

In one case, a respondent commented:

> *"Risk assessment overall is done automatically all the time, even though not in specific forms or in documents. However, maybe one should do this in a more systematic way after all."*
>
> *(Client project manager in project 3)*

The results about risk assessment are related to the answers in the first part, risk identification. The questions about risk assessment failed if there were no risks identified in the project involved. Since few clients have done any systematic risk identification, there are even fewer, 1 (of 9), who have responses to risk assessment.

Risk response

To find out more about the way clients respond to risks, questions have focused on what risks get responses, what kinds of responses, who decides and who is responsible for the control. There is also a question that directs the phenomena of responses without connections to any other steps in the risk management process.

Clients in these projects are careful in their specific demands on the contractor regarding risk responses. They think it is up to the contractor to find solutions and to control risks on site. They have not fully used their mandate to influence in which areas the contractor should put in extra effort to control the process, i.e. control the risks. In a few of the projects, (3 of 10), there are demands on controlling specific moments through either meetings or in the contractor's quality surveillance plan. In the other projects, clients rely on the construction documents and the demands put forward in them.

Clients, 3 (of 9), use timetables as a way to control the projects; they set a time and leave much to the contractor to control the process and reach the time related objective. They continuously follow up the timetable at meetings.

> *"I have managed this project through exact and tight timetables; the final date was important for us to be able to deliver our product to our customers"*
>
> *(Client project manager in project 2)*

One client relies on the individuals involved in the projects rather than the construction company. This respondent thought that it was much more important to have a good relation with the individual than having a contract with a specific company. When talking about how to control the project and the contractor, one client put it this way:

> *"Most of the time we have good construction documents where it says what to do, and then I am out on the site. The companies are good in their way, but it is the people at the site who are important, the personal relationship is more important than which company has employed that individual."*
>
> *(Client project manager in project 2)*

4.4.2 Analysis of clients work with risk process

There is a lack of systematic risk analysis amongst most of the clients in this study; hence, the answers to the interview questions are limited. However, 3 of 9 have some sort of management system to control the projects. The important step of risk identification is more or less lost in general building documents. The clients rely on the general documents and claim that 'all the contractor needs to know' is written there. It is up to the contractor to find out which parts could involve risks. The clients do not take responsibility for the risk management work in the projects and the continuous flow of information from the design phase.

A lack of time is one reason for not doing any risk analysis, as is confirmed in other surveys as well (Akintoye & MacLeod, 1997; Lyons & Skitmore, 2004). Using a timetable is the common control in construction projects, and the time is thus constrained.

The assessments used in the contributing projects are done with help from individual assessments based on the clients' background knowledge and experience. There is no systematic support as they present their work. The focus on the client's management systems has not gone beyond what is done at the specific projects involved, thus possibly creating a bias. This study has not examined the clients' management systems

The clients' most used risk response in the small projects is to transfer the risk to the contractor by agreements on general contracts using AB as the guideline. Previous research suggests that the most common responses are either contractual transfer, as in this survey, or transfer to professional indemnity insurance (Akintoye & MacLeod, 1997; Lyons & Skitmore, 2004).

In this interview survey the clients respond that the individual site manger is more important than the employing company. This result has been found in earlier research (Akintoye & MacLeod, 1997) where the project manager from the client claims that "project risk management is about people not scientific models", and point to the importance of relations of individuals rather than charming management systems presented by top management.

4.4.3 Construction management – the site managers and the contractors project managers

The aim of this section is to find answers to how risk management work is done from the contractors' viewpoint. The respondents are site managers and project managers from the contractor. At the end of this chapter is an analysis of the results from interviews with contractors.

Risk management system

There have been general interview questions about the management system and the risk management system in particular. The focus has been on if they have a management system and if so, does it include a risk management system. What is their perception of risk and risk management?

There is awareness of risks and uncertainties amongst all of the respondents in the study, though the systems presented often cover risks related to work environment. Risk management regarding the work environment is managed according to laws and regulations in the area and the responsibility is shared between clients and contractors.

> *"For me, risk analysis is mainly related to the work environment and accidents, not the economy."*
>
> *(Site manager in project 6)*

In the projects involved in this survey, there is a common attitude that these small projects are easy work and hence, without any risks. There is no time, need or resources to deal with risk management according to some of the respondents in these small projects.

> *"A lot of our projects have very short timetables and it's not possible to have time to plan the work"*
>
> *(Project manager in project 2)*

> *"There is just as much administration with a small project as with a larger project; there should be a difference in the demands of how much to do in different projects."*
>
> *(Site manager in project 9)*

> *"In the smaller projects the documentation is not as well maintained as in the larger ones. The important things are looked after in small projects, i.e. the high risks, but the risk analyses are not as thoroughly worked through in a smaller project."*
>
> *(Contractors project manager in project 5)*

"I think that it is much more work with a small project than it is with a larger one, but I am not able to pinpoint what it is."

(Site manager in project 10)

In some of the companies there are systems for quality management and risk management that tend to be extensive regarding the demands for documentation, and this is frustrating according to the respondents. They see the need for systems and are also able to support the contents of the systems when reviewing, but there is too much to do when at the site. The control is too detailed and the time is limited. One respondent put it this way:

"I do everything I am supposed to do according to the system and what is written in the checklist but in a very summarized way. Without a doubt there is an obvious risk to miss the most important and only focus on the demands from the system."

(Site manager in project 9)

There have also been plans in the projects to continuously conduct "follow-ups", but these have been rare in practice. When asked about this phenomenon, the respondents claim that no additional information or risks have occurred and no new risk identifications have therefore been necessary. In the companies with a risk management system, this has been an important part of the system, though not used in practice as it appears.

"It is seldom that we have complete construction documents in our projects. It is a judicial 'grey zone' and since there is a lack of proper documents, we do take an unnecessary high risk in these projects"

(Site manager in project 2)

This is an illustration of how the risk of insufficient contracts and documents are handled; the business goes on as usual despite the site mangers awareness of the presumptive risks.

"The opportunity to find a better solution is always taken care of, or else it would be foolish"

(Site manager in project 4)

Even though the opportunities have not been in focus in this study the close connections between the risks and the opportunities is exemplified through this last citation.

Risk identification and identified risks

For this part the questions to the respondent focused on what is being done regarding risk identification, how it is done and by whom. To get the respondents thinking, the questions were frequently reformulated during the interviews. Instead of only asking about the risks, questions regarding 'what makes you worried', 'are there any special difficult events to be conducted' and 'what keeps you awake at night in this project' were put forward.

Risks and uncertainties are generally identified during the tendering stage of the involved projects. Some projects, 4 (of 9), plan to continuously evaluate new and upcoming risks and uncertainties, but there have not been one project in this study where this has really happened. In many of the projects there have been risks identified in the tendering phase by people responsible for tenders, which have been the only documentation regarding risks. Site managers and project managers have not made any changes to these early identifications.

> *"Risks are identified early in the process, before the bid. It could be all kinds of risks such as technical risks, environmental risk, in other words anything that could jeopardize the project."*
>
> *(Contractors project manager in project 6)*

Risk identification is something ongoing in many projects, though not documented. There have been separate meetings in some of the projects, but in most cases risk issues have been part of some other meeting or process to identify and handle risks. It is also described as a process that is simultaneously ongoing with the rest of the project planning. The possible list of risks that would appear in the project is often together with the responses, i.e. an action plan to deal with risks and uncertainties. In some projects the 'tricky parts' appear on the list of internal quality surveillance. However, the process for how the 'tricky parts' end up in the document is unclear. The 'tricky-parts' are not necessarily viewed as risks either.

Project managers worry about the economics, but do not relate economics to a specific risk that needs attention. They relate it to either a lack of or misinformation in the tendering documents or their own or colleagues inability to do proper calculus in the tendering process.

In the cases involving blasting, risks were identified and risk analyses were performed early in the projects.

Similarly, projects close to traffic identified the traffic situation as a risk, though this is close to work environment risks.

Time uncertainty or lack of time is a risk pointed out from some of the site managers. Working in the winter or autumn is more risky than during the summer due to the weather conditions. It is also a qualitative risk to force the work to be done during one summer season instead of extending the work to two seasons.

One case had a good and systematic risk management system worked through, but there were still clear differences between the participated respondents regarding identified risks and responses. The client pointed out one risk in the project while the respondents from the construction company pointed out one or more each, but remarkably not the same risks. This project also had a special detailed work plan for one part of the construction that was extra critical, but not identified as a risk in the risk process. During the interview, however, it was clear that this was a risk in the project and the respondent realised a gap in the system.

Some of the projects have also had different views of what is identified as risks depending on who is responding during the interview. The site manager, project managers and the client all have different opinions of what they identify as risks in the same project.

Risk assessment

This part focuses on risk assessment and is highly dependent on the answers in the first part regarding risk identification. Questions have focused on how the identified risks have been assessed and by whom.

Several of the companies have formalized management systems to control the business, and do risk assessments through numerical judgments for probability and consequence. Descriptions of how to conduct these risk assessments are available. However, it seems that this is the way it is done on paper, but not always in practice. There are examples of properly filled in documents but still poor risk control.

The site managers rarely sit down and formally do any kind of risk identification or risk assessment**.** They point out a risk and then, that is what is being dealt with. The identification and the assessment steps, i.e. the risk analysis, in the theoretical sense are done simultaneously. The same pattern seems to apply for the site managers' superiors when they point out risks in the tender.

> *"I do not document the risk assessment I do; I put in extra money in the tender. Sometimes I allocate the money specifically for a certain risk, but not too often."*
>
> *(Contractors project manager in projects 3 & 8)*

"These risk checklists are filled in, but the real meetings and the shared thoughts are done during coffee breaks or over the phone, that's how works and the documentation is done very summarily. There is a big gap between how we and the systems work and this applies to us all, no question about it."

(Site manager in project 9)

Others claim that if the project is too simple and easy or too small, the risk management system will not be used; there is no money and time to do it.

The gap between the theoretical vocabulary and the practical approach to risk management was obvious in some of the interviews; there was a need to clarify questions during the interviews. One of the respondents answered this:

"-We do assessments all the time but, we don't think of it as risk assessment and we don't write it down in documents"

(Site manager in project 1)

Assessments are done without any formal help from numerical judgments. It is either the individual's own experience or that of the organizations, i.e. other colleagues' experience that is the base for the decision according to the respondents.

One other common way of doing the assessment is simply by individual judgment without any other tools or techniques. This is done in companies with formalised systems and in companies where there is no formal control of the risk process. A few respondents describe risk analyses as something done on a blank piece of paper, on the basis of the individual's background and experience. Another respondent described the assessment as:

"The actual assessment is based on experience and very much in my head"

(Project manager in project 7)

Yet another respondent says that he has no support when doing risk analysis, either from management systems or from the staff around him. He does it by himself and makes judgments from his experience.

The assessment and responses are closely connected to money. A commercial assessment determines whether or not it will cost money, i.e. if there is a risk or not.

"Anything we do at any time in the projects is an assessment of uncertainty"

(Contractors project manager in project 6)

Risk response

The essence of risk response was captured by interview questions about which risks have any responses related to them, what kind of responses used, who decides the chosen response and who is responsible for control of the responses. There is also a question that directs the phenomena of responses without connections to any other steps in the risk management process.

Responses to control identified risks are often some sort of detailed planning. In some cases the respondents claim that a certain risk or uncertainty was recognised early in the project, during tendering. These risks were handled through inclusion in the regular planning and are not visible in a specific risk management system. Hence, one cannot find any risk management system in use, though some sort of risk management has been applied.

Another common way to respond to identified risks is to add in some extra financing in the tender, sometimes allocated for that specific risk. If there is money allocated in the tender to deal with risks, it is often a combination of money to reduce the risk and deal with the result of a realized risk. The respondent in only one case claimed that the money was only allocated to reduce risk.

> *"Sometimes we allocate money in the tender for the site manager to see. The money is a combination of money allocated to prevent failures and as a measure to handle things that go wrong, but mainly for measures if things go wrong though."*
>
> *(Contractors Project manager in project 1)*

Detailed work plans are another common way of responding to risks and uncertainties. Interestingly is that there are special work plans for far more activities than there are identified risks. In most cases, it is up to the site managers to decide when and where a detailed work plan is needed, and the project managers only give advice and support if needed. One organization had different opinions about who was to decide the special work plan, when both the site manager and his superior claimed that each was the one to decide. It was obviously not controlled in any systematic way who was to be responsible. The work plans are only prepared and performed for complicated or critical parts of the construction. In one project, the site mangers used to refer to construction documentation when writing the detailed work plan to ensure that they would follow the construction drawings in detail in case faults would be built in and revealed later. The risk of having to deal with this during a specified guarantee time is then avoided. To do this, he ensures himself that the legal responsibility rests with the client, as this was a general contract. Sometimes, the detailed work plan is done verbally and not as a written document.

A serious and demanding client receives better performance from the construction company is another interesting claim from one of the construction companies. A client keen on risk analyses could expect better work from the construction company involved. In this single case, the respondent revealed that no extra effort is spent on a client who is not interested and keen on risk management. This construction company does not compel risk management for its own sake in their own company even though this respondent thought that it would do them good if they did. They could see the benefits from systematic risk analyses, but did not prioritize it during the production if the client did not push them.

To prevent and reduce the risks involved one respondent talked about common lunches for all the workers to stimulate communication and problem solving. They also had common meetings each mornings to prepare the days work.

Another respondent talked about how he follows up the work on site as:

> *"I do not follow up in any special systematic way; I put forward a lot of questions about the project to be updated concerning what is going on. I do not need to control the site mangers by demanding work plans, they are so experienced that they know what they are doing, and if not, they get back to me with questions."*
>
> *(Contractors project manager in project 1)*

As well as high reliance to experience and individual judgements there is also a high reliance to good planning to control the risks. The following citation exemplifies how two site managers perceive this.

> *"Good planning is a key to effective risk responses. If there is a shortage in any way it is my lack of planning that causes it. The system[16] is a good help if I only have the time to use it as a tool in my planning."*
>
> *(Site manager in project 10)*
>
> *"It is enjoyable with a project like this where it is clear that doing good planning at the start pays off, but at that same time it is a bit boring because nothing happens. No, seriously, this is the way it should be if talking about the construction business in general".*
>
> *(Site manager in project 1)*

[16] Quality management system

4.4.4 Analysis of the results from interviews with contractors

In accordance with previous research (Akintoye & MacLeod, 1997; Lyons & Skitmore, 2004), risk identification is done either by brainstorming or checklists attached to some sort of scoring. The systems available are there to keep the risk process tighter together, but fail because of the different individuals doing risk analysis at different steps in the construction process. The idea of keeping one document 'floating' throughout the process for continuous improvement is good but poorly followed.

The identified risks put forward have often been identified early in the process and then never revised, at least not documented. The continuous risk process is done in the head of management on site, hidden from other people if not verbally communicated. This leads to the result found in this study, where different key role individuals have different views of the risks in the same project. They have their own preferences which risks are the most severe, not the projects perspective of which risks are the ones that threaten the project objectives, Figure 19. The identified risks are of both dynamic and static character. The most focused are, however, the static risks that cover risks related to the work environment, safety and to some extent, the traffic situation. The dynamic risks are more vaguely described; still, these are the risks that are included in an opportunity to earn some money, the core business, and maybe this is the reason why. The risks are not considered in a risk perspective, but rather a business perspective.

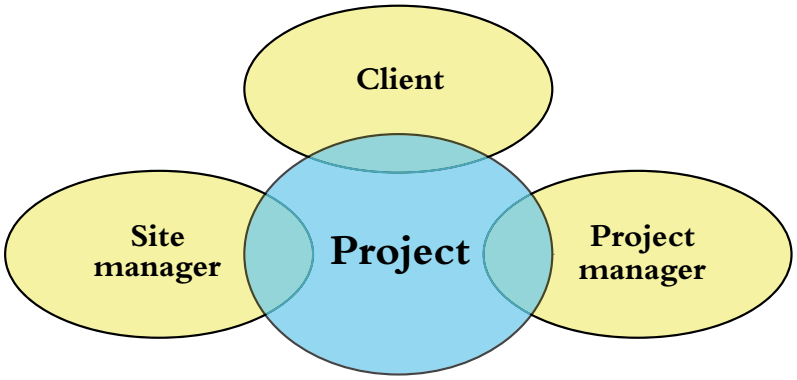

Figure 19. Different views of risks depending on role in the project.

There is, however, some sort of risk awareness in the projects. Quality surveillance plays an important role. Many special work plans are related to this control, since quality surveillance identifies critical parts in the construction process. Interestingly, few connections between the quality surveillance and the identified risks exist in the applied systems or the minds of the respondents. Still, both systems aim for the same thing, i.e. to reduce risks and uncertainties during the construction process. However, there is no

clear picture of how and why specific parts end up on these documents. The connection to any risk management thinking is lacking, and it is clearly a list of identified risks or risky events that needs attention. As a complement to those internal quality surveillance documents, the usage of detailed work plans is widely used as responses to control risks. The process of finding parts that needs special work plans also remains undisclosed. It is not obvious if these specially attended parts are found at any stage of the risk process even though they clearly could jeopardize the objectives of the project and therefore should be treated as risks. There is a gap between ambitions with management systems and practice.

Planning seems to be the main response to many of the risks and uncertainties in the projects. Either risks identified early are included and handled in the ordinary plans or special work plans are set up to control the risk. They have been neither identified nor assessed as a risk in any other way. Many of the risks at the site are retained or reduced; only a few are transferred to other parties.

A more diffuse way to respond to the risks in the project is to allocate money in the tendering phase. It is rather diffuse, since it is unclear if the money is to reduce the risk or if the money is in case something happens and the risk is retained as is. This common approach to risk response indicates that construction managers are risk aware, but do not control the risks, only showing that they know they can loose money. The awareness that they could loose money is in reality the essence in risk thinking, just as it is the core business of contractors to take care of things for others, i.e. take on risks from their clients for a certain amount of money.

The role of the client is important, since they own the project. A weak owner not wanting to use its mandate will get poor performance. If the client is able to bring a team feeling to the project, they will probably get better performance in the project.

> *"If I have a client project manager who is engaged in the projects, we perform better than otherwise. It shouldn't be like that, but unfortunately it is."*
>
> *(Contractors project manager in project 7)*

When risk management systems have been used and there are still failures, the failures only stress the fact that the system itself will not secure the company from risks. It is the individuals doing the identification and assessment with or without the available systems. Too rigid systems only give upper management a false security. If the individuals who work with the systems are neglected or forced into something they do not think will help them in their job, the system will fail.

4.4.5 Perceived obstacles and drivers for risk management

This set of interview questions aims to find answers to the fifth research question. Obstacles and drivers are more a matter of perception of risk management than a formal way to do things. To find out more about this issue, the interview questions focused on what factors influence their work with risks and what makes them frustrated. The answers are not sorted to specific groups of respondents but on the issues themselves.

Management system as a driver or obstacle

To handle the risks in a work environment, the systems should be a support to ensure that the legal demands are fulfilled. The economic risks are not handled so systematically. Many respondents do not feel that the management system has any effect on their way of handling project risks. One respondent, however, claims that he uses and gets support from their checklists for management of the site. His response is:

> *"With the 14 items on this checklist, there might be 5 that are totally irrelevant, but 3 that would have been forgotten if it had not been for that reminding checklist"*
>
> *(Contractors project manager in project 7)*

Another respondent used the system, but could see that by using the system one could loose sight of the real important issues in a project.

> *"There is a risk that more energy will be spent on fulfilling the system's demands than taking own initiatives in thinking."*
>
> *(Contractors project manager in project 9)*

Frustrations amongst a few of those respondents have concerned the management systems and their relation to the practical work on site. The frustrated respondents are found in all groups and feel frustrated regardless of years of experience, gender or educational background. Their opinion is that there is too much administration that has a bad influence on planning and the "real work". The frustration could also be related to an unsatisfactory quality in the construction documents, thus influencing the relation between the client and the contractor.

The form of the contract

Although the form of contract was not an issue during the interviews several interesting answers related to this. How the contract is formulated makes a difference regarding how the contractor and the client respond to risks. The smaller contractors seem to avoid anything but general contracts, if possible.

> *"Environmental risks are supposed to be mentioned in the construction documents, and we try to only work on general contracts and avoid build and design contracts."*
>
> *(Site manager in project 8)*

If they accept design and build contracts, they do consider the extra money for any uncertainty and added risk related to it. In a joint contract, there is a common responsibility for the risks that occur; in a general contract, the client takes many of the risks. One respondent from a small construction company says:

> *"In a design and build contract, I have to take more responsibility for risks and uncertainties. In a general contract there is always someone else to blame."*
>
> *(Contractors project manager in project 7)*

Another contractor explains the same thing with the following words:

> *"If it is a general contract I see the uncertainties as possibilities and not as risks"*
>
> *(Contractors project manager in project 9)*

Experience and background

According to most respondents, their experience and background plays an important role in the way they manage risks and uncertainties. They rely more on this than on the systems provided by the companies. However, several respondents are aware that their experience could be an obstacle, i.e. not being able to see things in a new way. They see it as a risk to become stuck in the way things always have been previously done.

The systematic return of experience to other projects or colleagues is poor. The experiences are shared during regular coffee breaks and gatherings a few times a year. One company described their work with follow-ups on the regulations (ÄTA[17]) done over the year, and how they gather all staff to discuss these 'faults'. The manager for this company revealed that:

[17] ÄTA, Ändring och tilläggsarbeten, Changes and supplementary works

"90% of what comes up at the annual gatherings are things that we have heard before and that we are familiar with. If it is a new experience we take the discussion, otherwise not."

(Contractors project manager in project 6)

Two other projects have meetings, one with the site managers six to eight times per year and the other after each season. An issue at those gatherings are experiences and lessons learnt.

In other companies and projects, there is hardly any work with learning from experiences according to the answer in the interviews. The individual is relied upon to put down their own 'lessons learnt', but no one in their organisation shares their experiences.

"I do not control the return of experiences in my organisation; it's up to the guys to talk with each other."

(Contractors project manager in project 3&8)

"We talk a lot amongst us project managers and my superior on a daily basis and thus we don't have to write things down."

(Clients project manager in project 2)

4.4.6 Analysis of results from questions about obstacles and drivers

The lack of formal training in risk management implies low knowledge and familiarity about formal risk management techniques. To expect to work in a way that you are not familiar with or that you do not see the benefits causes stress and frustration, as seen in this interview study. The low usage of formal risk management techniques is confirmed in a surveillance (Akintoye & MacLeod, 1997), where they find that the most used technique is intuition, judgement and experience, which hardly could be viewed as a formal risk management technique.

The way to handle and control the project is usually through planning a timetable, based on a Gant chart. This technique is almost synonymous with the control of construction projects and is the structure in the site manager's day-to-day work. From these results it is obvious that the risk management process is done parallel to this other control, not in symbiosis with it. For a small sized project this is not surprising, since control of the project relies on the site manager. Due to tight timetables, there is no time for new ways to control the project, but rather old and well-known working methods. By using well-known proceedings the site manager is able to focus on the project not the management system (MS), as the MS is perceived as something that does not contribute to the control of the project.

The form of the contract plays a significant role in the respondents' perception of risk. Transferring the responsibilities for the construction documents to another party also transfers the risk. The willingness to take on contracts is consequently different depending on the context for the contractor. Small companies are resist taking on contracts where they are responsible for the construction documents, since this means increased risk on their part. However, larger construction companies see the opportunities and the risks in build and design contracts.

The interview results from this thesis indicate a high reliance on experience and individual judgement, confirming previous research (Akintoye & MacLeod, 1997; R. J. Chapman, 2001). Another research project shows that experience is overestimated regarding its influence on risk identification (Maytorena, 2005). That result claims that it is the academic background with the most influence on the quality of risk identification, though this is not confirmed in this thesis.

The poor system, regarding the return of experiences and lessons learnt, give at hand that there are risks that appear continuously, without being dealt with on an overarching level. Previous research shows that approximately 60% of the failure costs in a project are due to 'inflicted uncertainty'[18]. (Nylén, 1999). The importance of experiences for the effectiveness and success of risk management is therefore obvious and should receive more attention than the results of this study reveal.

4.5 Results and analysis from studies of documentation

The documents used to search for information in this thesis are construction documents, memos from project meetings, management plans and anything specific about risks and risk management. Documentation about the construction companies' management systems has also been researched.

4.5.1 Results from studies of documentation

The bias in the documentation comes from the focus having been on the construction companies. As a result, the documentation of management systems in the client organisations has not been sought.

Each project has had a request to give access to documentation regarding the projects. Attitudes to sharing documentation have been positive even though the amount of documentation in each project differs greatly.

[18] Inflicted uncertainty is "Uncertainty that is inflicted in project organisations by actors' inability to learn from previous projects" (Nylén, 1999, p 18).

According to the documentation, most construction companies involved have management systems. Several of the projects have management systems in the companies, but they are not used at the project level. There is a gap between the company policies and the on site practice.

The documentation clearly focuses on risks related to the work environment. It is rare to find definitions or relations to other kind of risks. One project had a clear description of quality requirements in building documents from the client, but this was disregarded in the contractor's documentation.

4.5.2 Analysis from studies of documentation

The companies' ambitions are all in all good. However, the gaps between policies and company related risk management systems and the contrary on site practice is obvious. The systems are considered far too extensive to be applicable on site and the site managers therefore use their own experience and knowledge to control risks, often combined with poor documentation.

A few projects have a clear "red thread" regarding working with risks. Still, when comparing the answers in the interviews and the written word in the documentation, only bits of that thread are in place throughout the building process. The reliance to timetables is higher than on the project management plan.

There is no system in following risk and risk management from the clients' perspective. The clients rely on the contractor and do their follows-ups on the timetable and budget. This way of controlling the project is to use history to predict the future instead of predicting the probable future with a risk management system and then controlling those events found in the risk management system. In work environment related management this process is a healthier way to work. You try to predict hazardous events and then take precautions instead of waiting for something to happen and then input some safety measures.

The contractors in this study are problem-solving individuals who mainly control the projects in their head and hearts. They do a minimum of documentation and do not see the benefits by increasing the amount of documents.

This lack of documentation also causes a poor return of experience in the companies, since there is hardly any system regarding experience in the management systems studied in this study.

4.6 Summary

This summary section is a brief presentation of the highlights in the fourth chapter. For further information the author refers to each section of interest.

All in all, there is awareness amongst the respondents regarding risk management. The clients as a group are using formal risk management the least. Amongst the contractors, the larger companies have more administrative support for their risk management than the smaller companies. Despite this, the actions taken on site rely on the individuals more than on the available systems. It is therefore difficult to draw any conclusion on the effectiveness of the available systems and if the larger companies do perform "better" regarding risk management on site. This could very well be a finding connected to the small sized projects, since the respondents have pointed out the fact that the systems are used somewhat differently in small projects compared to large, though it is the same system and the same requirements.

Small sized construction projects have a pattern for managing the projects, where risk management can, with a generous interpretation, be seen as included. It is, however, not obvious how risk management theory is applied in practice. In Figure 21, the processes' relations to each other are drafted, where the 'doers' represent how many of the sites work, regardless of management system.

5 Discussions and conclusions

5.1 Closing the loop

The first and the second research questions addressed the issues of what kinds of methods and tools are used in the small construction projects and how these are used. The short and simple answer to this is that small projects lack systematic risk management. In a business where the core value is to handle continuously arising uncertainties, there must be someway to deal with this. This thesis concludes that the theoretical framework does not fit; small projects rely on the experience and personal judgements of individuals to do their risk management continuously throughout the project life cycle. Timetables, quality surveillance and detailed work plans are common methods used. Tools are either checklists or blank pieces of paper. This way of controlling risks and uncertainties is not to be regarded as systematic risk management.

The third research question aims to discover the kind of risk management applied in the construction companies involved, according to their policies. This is interesting, since these results reveal a gap between the policies and the management system versus the theoretical risk management found in the literature. It also reveals gaps between the policies and the applied practice on site. The conclusion is that there are gaps in both these aspects and it is more a matter of how large the gaps are. There has however not been any attempt to measure those gaps, only to state that they exist.

Beginning with a comparison between the policies and the theories, a gap exists in those companies that have risk management in their management systems. In the companies that have applied a risk management system, there has been accordance to the risk management process described in the literature. The applied management systems are supported in the theories even though there is a simpler version used in the companies. The steps, IAR[19] from the risk management process, are found in the site managers' work, but not in the strict order of the process and not with all the steps well-developed. It seems that the assessment is done with a subconscious judgement that, if specially asked for, is based on probability and consequence. The respondents state more often that judgements are based on their own experience and background knowledge. If pressed to answer further, they give a vague correlation to probability and consequence, which is immediately correlated by those working in risk management systems. The way to control risks on site is through planning; in the theoretical framework this is a form of response to already identified and assessed risks. In the companies that do not have risk management in their management systems or 'worse' do not even have documented management systems the gap is rather big. These companies have much to do if they

[19] Identification, Assessment, Response

want to implement formal risk management[20] at site level. With this knowledge, it is then not surprising that the project sites lack systematic risk management according to existing theories.

The comparison between policies and practice reveal that there are gaps even though companies have management systems that include risk management. Risk management systems in policies do not ensure that they are used at site level on projects. Of course, they are better prepared to use risk management, but this could also give top management a false security that risk management is working because it is included in the management systems.

The fourth research question focuses on previous research in the field of project risk management in construction. Previous research finds that the most used methods are brainstorming and checklists and that the reliance on individuals is high. The results show that despite different contexts a similar picture is revealed in construction projects. Hence, no matter where in the organisation or the size of the company, the reliance on individual judgements is high. A conclusion drawn from the studies of previous research is that the results regarding approaches to risk management found in various projects, organisations and management levels are similar to those found in this study. This could indicate a risk culture that is present in the construction sector rather than just a difficulty for small sized projects.

Previous research also shows a slow learning from previous experience. The system for return on previous experience is lacking and risk management process suffers from this. Therefore, the amount of epistemic uncertainty is unnecessarily high. If project organisations could learn from previous experiences, the amount of calculable aleatory risk would increase and benefit the companies and their organisations. Regardless, there is knowledge about risks and uncertainties in the organisations, where each project is viewed as unique and the organisational knowledge is not used. The amount of epistemic uncertainty in projects is unnecessary high due to lack of return of experiences, Figure 20.

[20] Formal risk management in the sense of risk management as described in existing theories.

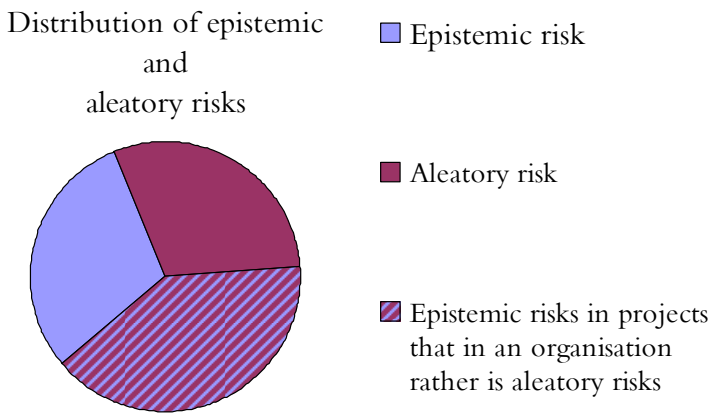

Figure 20. Distribution of epistemic and aleatory risks.

The fifth research question aims to find the obstacles and drivers for risk management. Not surprisingly, this was the most vague research question that was more based on a perception of risk than on hard facts. The answer to this is based on the overall results from the study and not on specific interview answers; it is the researcher's interpretation that gives the result to the research question.

The drivers for risk management are subtle in the interview answers. For the small projects, it seems like the driver mainly comes from the individuals involved and their attitudes. The driver is their engagement to their job. One driver that is not specified, but is probably rather important is that the core business of construction companies is to handle risks, and the driver for risk management is then to do business, i.e. take chances and risks until eventually they have made the right decisions and gained some more money. There are few drivers for using risk management systems according to the respondents. It is not a question of whether a formal management system works properly or not, that would have been a too easy an answer. The management system could be of help, but most often in those projects conflicts with the ambition of the system, or is at least not in line with the ambitions and feasibilities of the project.

The highlighted obstacles often have a relation to the management system or to the work situation on site. The obstacle related to the management system is basically separated in two parts;

- Lack of time to carry out all the steps in the risk process, IAR.
- Benefits from using risk management through formal systems are not obvious.

The obstacles could have their origins from various situations and backgrounds. The organisation on site could be one. Most often the organisation is tight; it is very much a

one-man show in the small projects where the site mangers have their share to handle. Anything that takes available precious time is an obstacle, and unfortunately risk management is one of those things. Even if a properly used risk management system aims to save time and money by thinking ahead, the managers involved in this study do not sense this. The lack of training in risk management and risk thinking could be another of those things that makes systematic risk management to be perceived as time-consuming and irrelevant thing to do.

The risk commitment from the client is another obstacle put forward. Only focus on the requirements spelled out in the contractual documents and do not include risk or risk management. The requirements that could be seen are demands on the contractor to present a risk analyses, but the clients seldom contribute to the contents of such risk analyses in the documents or in engagement. The conclusion here is that the client should be more engaged to make the small projects more efficient in a risk perspective. The requirements put forward in the documents should clearly define the known risks from the design phase, which have not been the case in the projects in this study.

The loop to be closed needs to be visualised in Figure 21, where the results from the different research questions are combined with each other. This figure shows how the approach to risk management differs from the practice on site and the theoretical risk process. Many of the practitioners on site, i.e. the 'doers', control their project by timetables and detailed work plans. The most important conclusion of this thesis is the importance of the individuals. It is the individual judgments that determine the result of the risk management system, irrespective of whether there is a system applied or not. The step of identification and assessment is merged to one step that follows from a more or less subconscious way of finding the risks. The work with identification and assessment that is done iterative through out the project is however not shown although it exists. This iterative way is not in a documented form or in the risk management process but comes in to the construction process when updating timetables and prognoses for economy. The 'cloud' of epistemic and aleatory risks that comes into the project illustrates the lack of awareness of those types of risks. Risks that come out of the project are related to static or dynamic risks on a concrete level of understanding.

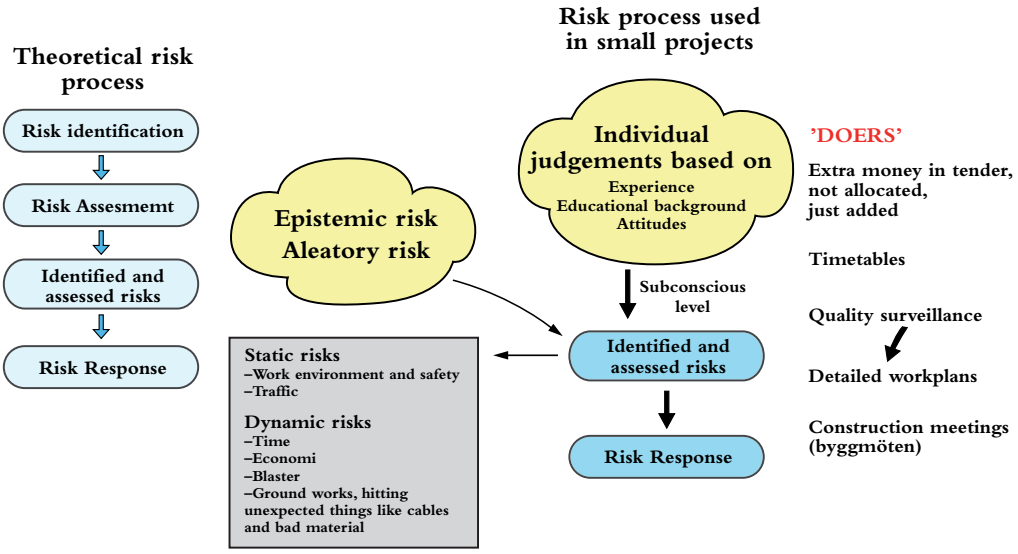

Figure 21. The comparison between how small projects apply risk management and the approach according to theories.

5.2 How to use these results

To progress in a certain direction it is essential to know where you are. This thesis has set the scene for the small sized project in the construction sector. An important contribution from this study is that one cannot rely and be dependent on risk management systems, as applied in small construction projects. There is a need for a simpler approach and a wider perspective that includes individuals much more.

Companies that wish to use and benefit from risk management should first start to educate their staff in risk management. They should also include more in the educational package than policies, routines and checklists, i.e. general risk thinking. They should talk about the individuals and use the existing way to manage and control projects, and develop those methods. By using existing documents such as quality surveillance and detailed work plans in a more risk aware sense, steps forward could be taken. Hence, if including risk awareness in already existing building meetings with shared responsibilities from clients and contractors, the financial benefits should be seen shortly. In this approach the individuals are familiar with how to manage the projects. A whole new way of doing things are not suggested, but rather small changes. Suggesting an improvement of the traditional way of controlling projects is to emphasize the importance of a systematic approach. The system should be straightforward and 'easy', but the important message is that there should be a systematic risk management approach.

5.3 Further research

A conclusion of this thesis is that risk management in construction projects relies on the individuals. For this reason, risk management theories today should focus more on the individuals. The personal judgements, based on experience and background knowledge, including education should be focused upon rather than the systems available in theory. The culture of the organisations and sector, where the individuals work, probably influence the risk management applied. Further research from this study is to learn more about the influence on risk management from the individual attitude as well as from the company and sector culture. Different organisations have different risk maturity and uncovering this relation to risk management is also interesting.

The individuals that make their judgement of risks do that in a certain context. This context differs from time to time and it is interesting to find out how the individuals cope with this. Also the risk and uncertainty in a project could well be changing through out the project life cycle. There need to be individuals that are able to adapt to the changing situations on the site and make good decisions in every new situation arising. The individuals hence need to be flexible and problem solving individuals. A further question is then if a problem solver inherently is a risk taker? Is there a relation to the

work situation for site managers and the individuals that seek challenges? The risk attitude of the managers in the construction sector is relevant to the approach taken by construction companies as such.

The theories of risk management lack the ingredient of individual and organisational influence and a development in this direction is needed. Finding a way that complements the existing theories with individual attitudes and the organisational culture should make risk management more efficient than it is today.

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Companies involved in the study.

NCC Construction Sweden AB

NCC Construction Sweden AB is active in building and civil engineering construction, housing construction, housing development and building services in Sweden. NCC Construction Sweden is by far the largest business segment within the NCC Group with approximately 7 600employees.

Skanska Sweden AB

Skanska Sweden AB is one of the business units in the international Skanska group. They are focused on housing and building construction and services related to road construction and civil engineering. Skanska Sweden are the largest construction company in Sweden with approximately 12 000 employees.

Frijo Entreprenad AB

Frijo Entreprenad AB is a unit in the old privately owned company Frijo AB. They work on a regional/local market in the region of Stockholm and their core business is ground works. The company has totally approximately 230 employees.

Nåiden Bygg AB

Nåiden Bygg is a privately owned company situated in Norrbotten. Their core business is housing and building construction. Their market is the northern parts of Sweden and they have approximately 95 employees.

Sh-bygg

Sh-bygg is a family owned company situated in Uppsala and Stockholm running in the third generation. Their core business is ROT (reparation, alteration and new construction), stone and ground, works. They have approximately 200 employees.

GLB Norrbotten

This is a small privately owned company situated in Luleå with the region of Norrbotten as their market. They focus on ROT projects in offices and public buildings. They have approximately 35 employees.

Vägverket produktion

Vägverket produktion is a self maintained business unit within the National Road Administration in Sweden. They work on a national market with focus on construction and maintenance in civil engineering and roads. They have approximately 2 500 employees.

Piteå Kommun

The community of Piteå, Piteå Kommun, is a small community in Norrbotten in the northern part of Sweden and they have approximately 41 000 inhabitants. They have their own unit for facility management (FM) which contract construction companies for some of their work through open tendering procedures.

Vattenfall

Vattenfall is Europe's fourth largest generator of electricity and the largest generator of heat. They act in all parts of the electricity value chain – generation, transmission, distribution and sales. They are also active in electricity trading and generate, distribute and sell heat at different communities in Sweden. Vattenfall have approximately 33 000 employees and are owned by the Swedish government.

Projektgaranti

Projektgaranti is a Consultants Company with construction management as their core business. They take their customers ideas through the construction process. In this study they have represented their customer Locum who is a large property owner in the region of Stockholm. Major tenants for Locum are healthcare institutions in Stockholm County.

Fortifikationsverket

The National Fortifications Administration operates as the Armed Forces property specialists. Their core competence is to provide a good working environment for their customs, the armed forces that will fulfil the requirements from the customers' special business.

Luleå Kommun

The community of Luleå, Luleå Kommun, is the largest community in Norrbotten with approximately 73 000 inhabitants. They have their own unit for maintenance of infrastructure which contract construction companies for some of their work through open tendering procedures.

The Swedish Road Administration

The Swedish Road Administration is the national authority assigned the overall responsibility for the entire road transport system. In each region they have project managers responsible for construction and maintenance projects in the road system.

Uppsalahem

Uppsalahem own and facilitates apartments on behalf of the community of Uppsala. They have approximately 12 500 units. Their organisation have approximately 230 employees.

IOGT-NTO

IOGT-NTO is the temperance organisation in Sweden and one of the largest associations in Sweden. They own some of the buildings and facilities where they have their activities and act as "one time clients" when doing refurbishments in those. In this study they have done refurbishment in one of their facilities where there are three other tenants using the facilities.

Risk management in small sized construction projects

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Abstract

Risks and other uncertainties can cause losses, which lead to increasing costs and time delays, both during the project and at the end. The need to prevent failures during the construction process and other losses related to construction has been emphasised in various reports. Example consequences are failure costs in civil works which can be close to 8% of the total budget for projects – more than 60% of these are costs due to 'self-inflicted' uncertainty. However, this paper is focused on small sized construction projects (in the range 1-15 MSEK), which are dominant in the Swedish construction sector today. They account for 83% of the total number of projects.

The aim of this paper is to describe how risks and uncertainties are managed in small sized construction projects. Some characteristics of these projects are presented, for example their organisation, financial size and type of contract undertaken. The paper identifies and describes the ways in which risk analyses are performed on a number of small projects today and where the common risks are believed to lie. The study is based on interviews with personnel selected from a number of construction companies. In order to be able to make improvements in the construction sector, a clear focus on uncertainties, which means both opportunities as well as risks, is needed. Organisations working mainly on small projects, that wish to improve their performance, need systematic methods for managing risks.

Small sized construction projects are found to be managed both intuitively, i.e. based on experience and systematically, i.e. using methodologies for risk and uncertainty management. The systems are, however, developed with the intention of fitting all sizes of projects and not specifically small sized projects. Some common risk sources in these projects are contract documentation and tight schedules, the client, individual planning and logistics, cost estimates used to compile the tender, subcontractors, technical solutions, safety of third parties and weather.

Keywords: risk, uncertainty, risk management, uncertainty management, small projects

1. Introduction

1.1 Background

Risks and other uncertainties can cause losses, which lead to increased costs and time delays, during the currency of projects and at their end. The need to prevent failures in the construction process and other losses relating to projects has been highlighted many times over the years and figures strongly in a recent major report in Sweden [1].

The most common project size in the Swedish construction sector is less than 15 MSEK (roughly €1.65m). In the study reported in this paper, projects in the range 1-15 MSEK have been chosen, whilst those in the range of 0-1 MSEK have been excluded. According to Sveriges Byggindustrier [2], as much as 83% by number of projects are in the range of 1-15 MSEK. The reason for choosing this particular segment is that the smallest projects, the ones between 0-1 MSEK, are less interesting from a project risk management perspective. Their nature is inherently more like continuous business than project-based.

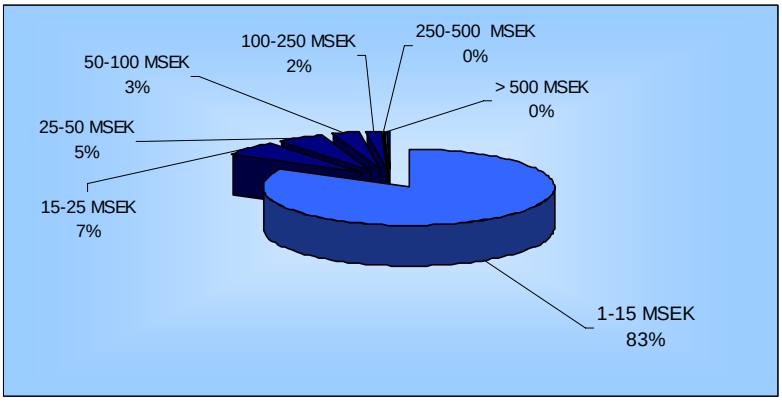

Figure 1. Number of projects divided into segments in relation to their size in the Swedish construction sector 2004.

Risk management and other types of applied management have been used routinely in construction projects, but have often been exclusive to large and exposed projects. Studies tend to cover large-scale projects, often with many different participants [3], [4] and [5]. The risks cover a spectrum of events from financial, political and legal to technical, often relating to complex construction.

In one study [6], failure costs for civil works were identified as being close to 8% of the total budget for projects and more than 60% of those costs were due to 'self-inflicted' uncertainty. The study also focused on large projects and clients' perspectives. 'Self-inflicted' uncertainty is

due to ignorance of earlier experience of failures that continue to appear in similar projects in the future.

In small sized projects, the risks are more moderate and the consequences are less dramatic. These projects are more vulnerable to changes of the kind that have an impact on time since there is less chance of catching up if the schedule slips. On the other hand, the nature of the construction work and the project environments are often rather straightforward and the technical challenge is limited. This picture of the situation for small sized construction projects is based on the author's own observations and that of the study's reference group.

1.2 Aim and objectives

The aim of this paper is to describe how risks and uncertainties are managed in small sized construction projects. Three specific objectives have been set as follows.

- Present the characteristics of small sized construction projects.
- Describe the ways in which the risk analyses are performed today.
- Define common risks that occur in small sized construction projects.

In order to reach these objectives, interviews have been conducted to collect data.

This paper presents the results of a pre-study forming a part of a research project which is investigating uncertainties in small sized construction projects. The research question to be answered in the pilot study is 'how to find out how risks and uncertainties are managed in small sized construction projects today'. Further research questions to be addressed in the research project are related to the relationship between theories, companies' policies and practical work, and also to the identification of obstacles and ambitions/incentives for uncertainty management in small sized construction projects.

1.3 Definitions

1.3.1 Small sized construction projects

Searches of the literature did not provide conclusive evidence of what exactly characterises a small sized construction project, neither did discussions with different actors in the sector. The characteristics of a small sized project were subsequently discussed and agreed within the study's reference group. The result is sufficient description to distinguish these projects from very small projects, which are more in the nature of continuous business operations and, at the other end of the scale, from large projects.

The characteristics agreed upon of small sized projects for the purpose of this study are:

- contract value between 1-15 MSEK
- a site manager responsible for a maximum of two projects simultaneously
- limited construction time, maximum 12 months
- established technique, no development work
- project environment is independent
- personnel involved are more generalist than specialist

1.3.2 Risk and uncertainty

In order to be able to discuss risks and uncertainties there needs to be some sort of definition of these concepts within the study. Uncertainty is part of everyday life, since we are not able to predict the future accurately. The amount of uncertainty and the ways in which we can handle this uncertainty could, however, be defined and structured.

According to Aven [7] uncertainty could be either aleatory or epistemic. An aleatory uncertainty is of a random nature and is hard to predict. An epistemic uncertainty is "lack of knowledge about fundamental phenomena", which refers, for example, to the use of models and assumptions. In this study, uncertainty refers to both aleatory and epistemic uncertainty using Aven's terminology.

Chapman and Ward [8] state that there is a need for a clearer focus on the upside effects, i.e. the opportunities. They also think that is desirable to let go of the historically close connection to events, conditions and sets of circumstances and instead shift attention to the different sources of uncertainty that could lead to threats of failure or, equally, opportunities. Their opinion is that it is vital to understand where and why uncertainty is important in a given project context and not to focus solely on threats and opportunities connected to given events, conditions or circumstances. Chapman and Ward [8] continue their line of argument with the suggestion that "uncertainty management" should replace traditional "risk management" to indicate that a wider perspective is being sought. This study starts with the aims of Chapman and Ward in order to widen the concept of risk management and use the concept of uncertainty management in its place.

The definitions of risk and uncertainty found in the literature are not consistent. There are several different definitions and approaches from different areas of research. According to the Project Management Institute [8] a definition of risk should take into account both positive and negative effects on a project objective. This is a broad view in terms of threats and opportunities and how they are connected to an event, a condition or a specific circumstance. Even if the risk according to [9] includes upside effects, the tradition is to focus on the downside, i.e. the negative effects. Project risk is defined as the "combination of the probability of an event and its consequences for project objectives" [10]. This definition is well known in the construction

sector and elsewhere and is, by tradition, closely associated with a threat. Conversely, opportunity is neglected despite the enlightened definition found in [9].

It is necessary that each study defines its own approach and view of risk and uncertainty. In this study, the term uncertainty is used to point out the possibilities for both types: “risks”, with the negative effects; and “opportunities”, with positive effects. The definition of risk used here focuses on the negative outcome of an uncertainty and is seen as more dramatic than uncertainty.

Uncertainties are handled everyday on a construction project, but not all are of the type that needs special attention. In this study, uncertainty is defined as something that occurs and which was neither foreseen in the project description nor in the contract, being often caused by lack of knowledge on the part of one or more of the parties. The uncertainty could be an event that occurs during the project. It could also be something that is known from the beginning that makes the project unique, i.e., that makes it different from the standard procedure. Those uncertainties could lead either to risks or opportunities and need to be taken into account.

1.4 Research limitations

Risks appear at different levels and likewise have different consequences for their surroundings. Depending on the approach taken, different risks will be found. In this study, risks in construction projects are examined, from the contractor’s perspective. Risks that appear at other levels are not considered, although they could affect the project’s objectives (figure 2).

Figure 2. Selected approach for this project.

In the context of a construction project some further limitations regarding uncertainties and risks are considered in the study. Risk sources which are outside the framework of the study are, for example, political decisions, the financial situation of the client as well as the contractor, changes in organisation and illness among personnel involved in the project. These risks could have both positive as well as negative effects on the project's objectives, but are often out of the control of the site manager. For that reason, they will be left outside this study. Risk sources that are to be considered in this study are the project's economic boundaries, relationships with the client, technical solutions, aspects of production and weather. These risks are either within the control of the site manager or affect the project directly without interference from other levels of the company's organisation, for example, weather. Between these defined areas, risk sources from geotechnical engineering and the work environment will be found. These two areas represent many of the risks in the construction sector and have been studied separately earlier in other studies [3]. For this reason, they will not receive any special attention in this study.

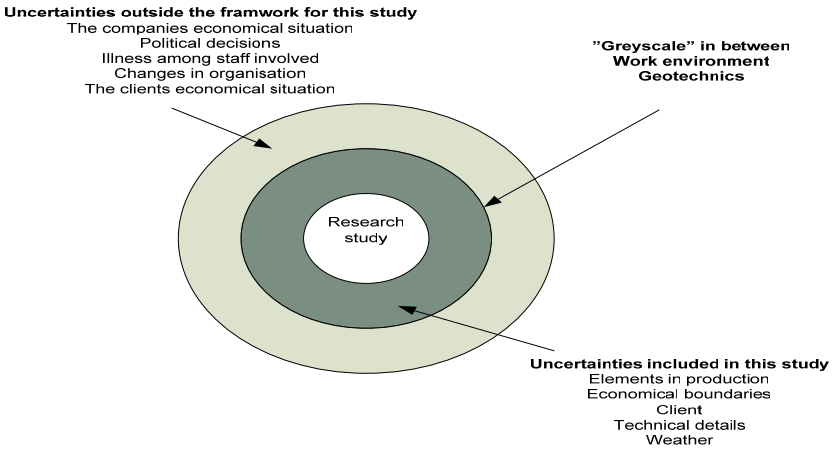

Figure 3. Risks and uncertainties in relation to the project.

2. Risk management today

2.1 Collection of data

2.1.1 Method for data collection

The principal method used to collect data is interviews with managers of different projects from different companies. The strategy used for selecting projects is that the project must be either in a state of production or “fresh in memory”. Projects that have just started have not been selected because of the risk of the researcher affecting how risks are managed if the project is in the planning phase. There could be, as well, uncertainties in the answers if the projects were finished and the site manager had moved on to another project. Projects should also be selected according to criteria in the definition of small sized projects, not by who happens to be the site manager. Interviews with managers of projects from different construction companies have been adopted to provide a flavour of the wider construction sector.

In order to be able to see patterns in data from the interviews, the information has been sorted into different categories. Projects have been sorted by type: buildings, new production and renovation, and ground works. There is also some categorisation relating to the geographical situation, i.e. a medium sized community such as Luleå and a large city such as Stockholm, and the age of the site managers.

2.1.2 Interviews

Ten interviews have been undertaken with personnel from five different construction companies in Luleå and Stockholm, Sweden. The interviews were conducted in a semi-structured manner with a number of questions prepared in advance. The interviewees were free to speak about risks and opportunities in their projects and the researcher asked questions and gave some guidance to ensure that the prepared questions were covered. The interviews were conducted in a positive atmosphere and the interviewees have expressed an interest in seeing the final results of the study.

2.2 Findings

The findings from the interviews give a picture of what site managers in a few small sized construction projects think about risk management. They have shared both how they work with uncertainties, risks and opportunities and also indicated what they regard as the most common risks from their perspective. They have also given their view on what is defined as risk and uncertainty.

2.2.1 Perspectives on risk management

According to the site managers, risk is something that can have negative consequences for the project and is more dramatic than uncertainty. Conversely, uncertainty is regarded as something that can have positive as well as negative effects.

According to the site managers of the projects investigated, there exists a systematic framework for how risks and uncertainties are managed. There are manuals, routines and patterns to be used, not specifically for small sized construction projects, but specific to the actual type of project. For example, there are manuals for risk identification in ground works, general construction and buildings.

Managers of these small sized projects use the manuals and patterns to a certain extent, with some differences in application amongst them. They apply what they think is useful and leave the rest of the documentation alone. It is notable that there is a difference between the interviewees with respect to their age and experience. The older and more experienced managers tend to document less than others. This means that there are some who actually follow a systematic approach and others who work on intuition based on experience. Common for several of the managers is that they think continuous planning is the best way to manage uncertainties. “Risk analysis is quite good, but it is good planning and logistics that offer the best possibility for minimising uncertainties” (Andreas Rydberg, site manager NCC). In terms of planning, they are able to identify new uncertainties and to take precautions with respect to risks identified in the risk analysis. Risk analysis is performed for the tender and is part of the information the site manager gets before he takes on the project. The site managers refer to this risk analysis as a “living document” that should follow the project throughout the construction process. However, there are differences in how this is actually performed.

Risk analysis and “risk thinking” is not dependent on project size according the site managers interviewed. The approach to risk thinking is more dependent on the type of project than on the contract size of the project. It is the consequences of the risk that decides if the risk is qualified in the risk analysis and, in the first instance, the consequences for health and safety (Patrik Lamberg, Skanska). There are neither differences in available documentation nor in the extent of information in the documentation between large and small sized projects. This means that in very small projects the managers think that more time would be consumed to do documentation for the sake of the system than is actually required for production. The consequence of this is that the managers skip part of the documentation, if not most of it. There is also a time related aspect of these small sized projects expressed by this site manager: “In small projects it is vital that the personnel involved start off immediately since the time available is limited” (Leif Eklund, NCC). There are more possibilities to save a large project if a risk should appear, but the consequences of that risk if not saved might be large. The consequences of that same risk in the small project would be less, but might not be as easy to save due to tight schedule.

2.2.2 Identified risks

In the small sized projects there are some risks that are more common than others. The relation to the client is one; lack of information in documents provided by the client is another. Yet another risk or actual uncertainty is the tender that establishes the boundary of the project. It is not possible to receive more money than the tender (i.e. contract) sum. The interviewees also think that there is a considerable difference in approach to risks and opportunities depending on what kind of contract is used. General contracts are considered safer in all respects. All aspects should be included and if something is missing it is the client's responsibility to solve the problem, not the contractor's responsibility.

For ground works projects the managers feel that there are a few risks. Small projects are rather straightforward, with known technology and known conditions in the project environment. The risks that appear are the same ones from time-to-time and there is limited uncertainty that crops up along the way.

In renovation projects, more uncertainties appear during production. The activities and technical solutions often need to be adjusted at the site level due to lack of information in the tender about the existing building. There are seldom standard solutions and whether something is a risk or an opportunity is much dependent upon the attitude of the client. Since there is a lot of uncertainty when doing renovation work it is hard to achieve a complete and reliable cost estimate for the tender. The tender (and, hence, the contract sum) does, however, define the financial boundaries for reaching the objectives of the project. This is also to be considered as an uncertainty.

One considerable uncertainty in new building projects is a tight schedule. Physical factors such as drying time for concrete are sometimes neglected, with the consequence that projects can end up with damp concrete. The risk of built-in faults could cause higher costs for both the contractor and client if not handled properly. Building projects also often include subcontractors and this involves uncertainties in relationships as well as in their attitudes to risk and uncertainty management.

Common risks for the small sized projects in this study are, without any ranking:

- contract documentation and tight schedules
- the client
- individual planning and logistics
- cost estimates in the tender
- subcontractors
- technical solutions
- safety for third parties
- weather

3. Conclusions and further research

The definition and characteristics for small sized projects are:

- contract value between 1-15 MSEK
- a site manager responsible for a maximum two projects simultaneously
- limited construction time, maximum 12 months
- established technique, no development work
- project environment is independent
- personnel involved are more generalist than specialist

Results from interviews show that there are common factors for small sized projects. These projects are managed both on intuition based on experience and systems for risk and uncertainty management. The systems are, however, developed with the intention of fitting all sizes of projects and are not specific to small sized projects. This leads to differences in the ways of applying risk management and is much dependent upon who is doing the risk analysis more than what the management system might advise. Site managers are also dependent on their own planning rather than having support from other personnel in the organisation.

Results from this pre-study have helped to sharpen the questions to be addressed in the next stage. The aim is also to give a picture of where risk management in small sized construction projects stands today. Knowledge about this situation makes it possible to continue with the remaining research questions:

- What are the differences between theories, companies guiding principles and the practical work in order to conduct uncertainty analyses?

- Why does uncertainty management work satisfactorily in some projects and not in others? What are the obstacles and ambitions of uncertainty management?

The plan for future work is to perform case studies during late 2005. In those case studies, further empirical results will be collected in order to arrive at an understanding for the performance of uncertainty management in small sized construction projects. The result of this future work will be a licentiate thesis to be finished by late 2006.

Acknowledgements

The author would like to thank the people involved in the research project's reference group for inputs and discussions in the research area. They have been of great help in the task of finding

definitions and defining research boundaries. The reference group consists of people from different companies representing clients, contractors and consultants with practical as well as research experience. They have all reached advanced positions in their field and it is a major benefit for this study to have access to their experience and knowledge.

Thanks are also due to Valter Hultén of Sveriges Byggindustrier for his help with statistics on number of projects.

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Intervjuer Platschefer

Vad vill jag ha svar på?

Analyser

- Analysera orsaker till skillnad i riskidentifiering, värdering och åtgärd sorterat på aktör och projekt
- Analysera skillnader mellan projekten inom samma kategori, ROT eller Mark
- Analysera och hitta samband mellan vems bedömning som ligger till grund för styrning av osäkerheter. Sök samband som går att förklara kopplat till hinder och drivkrafter.
- Beskriv skillnader mellan planerad risk/osäkerhetshantering samt projektutfall i form av uppnådda mål samt utfall av risker/skador och olyckstillbud.
- Beskriv hur systemen för osäkerhetshantering ser ut, är det ett helt system eller är det delar av system som tillämpas?

- Teorier om osäkerhetshantering och hur dessa tillämpas
- Företagets teorier och tillämpningar och i osäkerhetshantering
- Projektets arbete med osäkerhetshantering, hur och om det tillämpas

Analysresultat sammanställs i flera olika dimensioner;

- Projekt och dess riskhanteringssystem, dvs identifiering, analys och åtgärd
- Aktörer
- Kategori av projekt

Frågeställningar

Inledande frågor -Platschef

- Berätta vem du är?

Namn
Ålder
Kön

- Hur länge har du arbetat i det här företaget och i branschen?

Erfarenheter från branschen

- Vilken typ av projekt brukar du ansvara för?

Erfarenheter från branschen

- Vad har du för utbildningsbakgrund?

Grundskola
Gymnasieskola
Högskola/Universitet

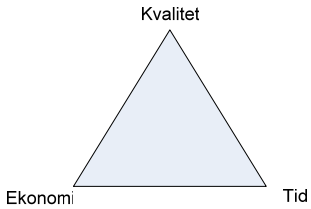
- Vad har du fått för interna utbildningar?
  - Inom Risk och osäkerhetshantering
  - Inom projektledning allmänt
  - Inom kvalitetsstyrning
  - Direkta yrkesutbildningar tex betongkurs, arbete på väg mm.

Huvudfrågor

Projektet

- Beskriv det här projektet?
  - Storlek
  - Kund
  - Typ av projekt
    - Bygghandling som dokumentation

- Hur har projektstyrningen fungerat i det här projektet?
  - Toppstyrt, dvs styrt ”utanför” projektet
  - Styrt utan inblandning, dvs direkt från PC



- Hur sker prioritering ut i det här projektet om du utgår från ovanstående bild med K, T och E?

- Vilka är konsekvenserna av den här prioriteringen?

- Finns det UE i det här projektet och hur styrs de?

Riskhantering

Vilka är dina största orosmoment för det här projektet?

Vad är du frustrerad över?

Beskriv hur du har hanterat dessa orosmoment och frustrationer.

Har du eller någon annan gjort någon riskbedömning och hur har den i så fall gått till i det här projektet?

Ge en beskrivning av flödet? -dokument
Vem och vilka har deltagit? -dokument
Vilken typ av hjälp finns för att göra riskhantering, tex checklistor, böcker mm.? -dokument

Vilka dokument kommer fram som resultat av riskhanteringsarbetet och var och hur används dessa?

Vilka risker har identifierats?
Vem eller vilka har identifierat riskerna?
Upptäcktes några nya risker jämfört med tidigare projekt?

Hur har bedömningarna av riskerna genomförts?
Vem eller vilka har gjort bedömningarna? -dokument
Vilka parametrar har spelat in (tex sannolikhet och konsekvens)? -dokument
Har det funnits några hjälpmedel till detta?

Hur ser eventuella åtgärderna ut som svar på de identifierade riskerna?
-dokument

Finns det arbetsberedningar för några särskilda moment och i så fall vilka?
-dokument

Vad och vem är det som avgör när det ska tas fram en arbetsberedning för ett särskilt moment?

Hur fångar du upp nya osäkerheter som dyker upp i projektet?

Hur förs erfarenheterna från det här projektet vidare till nästa projekt?

Vem har synpunkter på om och hur du gör din riskbedömning
Från vem får du ”skäll”?
Från vem får du beröm?

Vilka faktorer påverkar ditt sätt att hantera risker?
Företagets verksamhetssystem?
Kontraktsformen på projektet?
Din egen erfarenhet och bakgrund?
Projektets övriga aktörer?

Finns det något övrigt Du vill tillägga som har med osäkerhetshantering att göra?

Intervjuer Affärschefer

Vad vill jag ha svar på?

Analyser

- Analysera orsaker till skillnad i riskidentifiering, värdering och åtgärd sorterat på aktör och projekt
- Analysera skillnader mellan projekten inom samma kategori, ROT eller Mark
- Analysera och hitta samband mellan vems bedömning som ligger till grund för styrning av osäkerheter. Sök samband som går att förklara kopplat till hinder och drivkrafter.
- Beskriv skillnader mellan planerad risk/osäkerhetshantering samt projektutfall i form av uppnådda mål samt utfall av risker/skador och olyckstillbud.
- Beskriv hur systemen för osäkerhetshantering ser ut, är det ett helt system eller är det delar av system som tillämpas?

- Teorier om osäkerhetshantering och hur dessa tillämpas
- Företagets teorier och tillämpningar och i osäkerhetshantering
- Projektets arbete med osäkerhetshantering, hur och om det tillämpas

Analysresultat sammanställs i flera olika dimensioner;

- Projekt och dess riskhanteringssystem, dvs identifiering, analys och åtgärd
- Aktörer
- Kategori av projekt

Frågeställningar

Inledande frågor –Affärschef/Arbetschef

- Berätta vem du är?
  - Namn
  - Ålder
  - Kön

- Hur länge har du arbetat i det här företaget och i branschen?
  - Erfarenheter från branschen

- Vilken typ av projekt brukar du ansvara för?
  - Erfarenheter från branschen

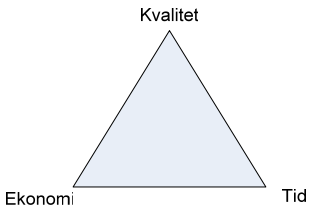
- Vad har du för utbildningsbakgrund?
  - Grundskola
  - Gymnasieskola
  - Högskola/Universitet

- Vad har du fått för interna utbildningar?
  - Inom Risk och osäkerhetshantering
  - Inom projektledning allmänt
  - Inom kvalitetsstyrning
  - Direkta yrkesutbildningar tex betongkurs, arbete på väg mm.

Huvudfrågor

Projektet

- Beskriv det här projektet
  - Storlek
  - Kund
  - Typ av projekt



- Hur sker prioritering ut i det här projektet om du utgår från ovanstående bild med K, T och E?
- Vilka är konsekvenserna av den prioriteringen?
- Finns det UE i det här projektet och hur styrs de?

Riskhantering

- Beskriv företagets policy när det gäller riskhantering?
- Hur ser ledningssystemet ut för att säkra att man når uppställda mål?

  -dokument
- Vem har synpunkter på om och hur du gör din riskbedömning?
  - Från vem får du ”skäll”?
  - Från vem får du beröm?
- Hur har riskhanteringen gått till i det här projektet?
  - Ge en beskrivning av flödet -dokument
  - Vem och vilka deltar –dokument

- Vilken typ av hjälp för projektledningen finns för att göra riskhantering? -dokument

- Vilka dokument kommer fram som resultat av riskhanteringsarbetet och vad händer med dessa?

- Vad och vem är det som avgör när det ska tas fram en arbetsberedning för ett särskilt moment?

- Hur fångas nya osäkerheter som dyker upp i projektet?

- Hur förs erfarenheterna från det här projektet vidare till nästa projekt?

- Vad är du frustrerad över i det här projektet?

- Vilka faktorer påverkar ditt sätt att hantera risker?
    - Företagets verksamhetssystem?
    - Kontraktsformen på projektet?
    - Din egen erfarenhet och bakgrund?
    - Projektets övriga aktörer?

- Finns det något övrigt Du vill tillägga som har med osäkerhetshantering att göra?

Intervjuer Kunder/byggledare

Vad vill jag ha svar på?

Analyser

- Analysera orsaker till skillnad i riskidentifiering, värdering och åtgärd sorterat på aktör och projekt
- Analysera skillnader mellan projekten inom samma kategori, ROT eller Mark
- Analysera och hitta samband mellan vems bedömning som ligger till grund för styrning av osäkerheter. Sök samband som går att förklara kopplat till hinder och drivkrafter.
- Beskriv skillnader mellan planerad risk/osäkerhetshantering samt projektutfall i form av uppnådda mål samt utfall av risker/skador och olyckstillbud.
- Beskriv hur systemen för osäkerhetshantering ser ut, är det ett helt system eller är det delar av system som tillämpas?

- Teorier om osäkerhetshantering och hur dessa tillämpas
- Företagets teorier och tillämpningar och i osäkerhetshantering
- Projektets arbete med osäkerhetshantering, hur och om det tillämpas

Analysresultat sammanställs i flera olika dimensioner;

- Projekt och dess riskhanteringssystem, dvs identifiering, analys och åtgärd
- Aktörer
- Kategori av projekt

Frågeställningar

Inledande frågor –Byggledare/Kund

- Berätta vem du är?
  - Namn
  - Ålder
  - Kön

- Hur länge har du arbetat i det här företaget och i branschen?
  - Rollen som byggledare

- Vilken typ av projekt brukar du ansvara för?

- Vad har du för utbildningsbakgrund?
  - Grundskola
  - Gymnasieskola
  - Högskola/Universitet

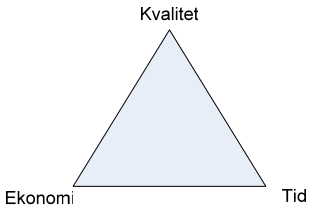
- Vad har du fått för interna utbildningar?
  - Inom Risk och osäkerhetshantering
  - Inom projektledning allmänt
  - Inom kvalitetsstyrning
  - Direkta yrkesutbildningar tex betongkurs, arbete på väg mm.

Huvudfrågor

Projektet

- Beskriv det här projektet?
  - Storlek
  - Entreprenör
  - Typ av projekt

- Placera in projektet i målbilden, dvs hur såg målbilden för prioriteringar ut i det här projektet?



- Vilka är konsekvenserna av den prioriteringen?

Riskhantering

- Beskriv byggherrens/Er policy när det gäller riskhantering?

- Hur ser Er styrning ut för att säkra att projektet når uppställda mål?
  -dokument

- Vilka faktorer påverkar ditt sätt att hantera risker?
  - Företagets verksamhetssystem?
  - Kontraktsformen på projektet?
  - Din egen erfarenhet och bakgrund?
  - Projektets övriga aktörer?

- Vem har synpunkter på om och hur du gör din riskbedömning?
  - Från vem får du ”skäll”?
  - Från vem får du beröm?

- Hur har riskhanteringen gått till i det här projektet?
  - Gör Ni som kund någon egen riskbedömning?
  - Ge en beskrivning av flödet -dokument
  - Vem eller vilka från kundens sida gör i förekommande fall riskbedömningar?
  - Vilka dokument kommer fram som resultat av riskhanteringsarbetet hos Er?

- Vad och vem är det som avgör när det ska tas fram en arbetsberedning för ett särskilt moment?

- Hur fångas nya osäkerheter som dyker upp i projektet?

- Hur förs erfarenheterna från det här projektet vidare till nästa projekt?

- Vad är du frustrerad över i det här projektet?

- Finns det något övrigt Du vill tillägga som har med osäkerhetshantering att göra?