CHALMERS
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Analysis of Construction Organizations Risk Management

Master's Thesis in the Master's Programme Infrastructure and environmental engineering.

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Cover:
Picture of the risk subject (mcgregor, 2016).
Construction management, Göteborg, Sweden, 2016

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ABSTRACT

In this report, the specific risk areas relevant to construction industry and the risk management process surrounding are addressed. It also tries to understand the hierarchical structure of risk management within a construction company. Published studies and general information regarding the subject were investigated and summarized into a literature review. New research information was then gathered through interviews and surveys, carried out on a specific case study company. The questions addressed revolve around the risk management process and how it is carried out in such a company today and how different risks are perceived and valued from different managerial levels and viewpoints. Through this report some areas were discovered to be in need of development to fully fulfill the requirements of larger clients and certification of international guideline standards such as ISO. Although the focus of risks differs between managerial levels, as to be expected, there is a strong culture of risk management involved throughout the organizational ladder. Risk management is understood to be an important tool that is highly integrated in the work of managers. What is mainly lacking is a structured, comprehensive system instead of a more project specific risk management for better communication, documentation, revisions etc. A valuation ranking of risks from different perspectives gave the understanding which risks are most interesting for such an organization. This could help show where energy and resources should be focused on in the development of future risk management work and procedures.

Contents

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Preface

In this study, interviews together with a survey have been performed on a company in the construction industry. The work has been carried out between December 2015 and June 2016. The thesis is done as an analysis of work regarding risk within the construction industry. The Department of Construction management, Chalmers, University of Technology, Sweden.
The work has been conducted with Docent Mathias Gustavsson as supervisor from Chalmers. The interviews and the surveys included in this work were all carried out on a case study company. A special thanks should be given to the team at the case study company that helped us coordinate the work and provide respondents for interviews and survey that was needed for the study.

Gothenburg Spring semester 2016
Gudmundur Fridriksson & Anton Jonsson

Introduction

Risk is a commonly used term which has been defined in several ways, (Kartam & Kartam, 1999) but to summarize it Anthony Mills says in his survey (2001), "risk is defined as the chance of an adverse event to occur" or as described in common dictionaries "the possibility of loss" (Yates, 1992, ss. 4-11).
All organizations are governed by both internal and external factors that influence the goal of their business. In the construction industry risk management is an important but often overlooked subject due to that the construction industry is so dynamic, risky and challenging with several factors to include (Mills, 2001). The reason why it is so important is that projects tend to go over budget and get delayed as a result of risks that have not been assessed or planned for at earlier stages in the project. The sooner decisions are made in a project the bigger the difference and gain is at the outcome. Depending on the severity of the problem, the consequences can result in a heavy cost due to a failure or oversight in the risk assessment.
The construction industry is constantly developing and adjusting with increasingly stricter requirements implemented throughout the construction process (ISO Technical Management Board Working Group, 2009). This includes everything from development, preservation and maintenance of infrastructure, to working with environment and safety where risk factors must be assessed and unwanted incidents managed or eliminated. There is a demand for minimum risk tolerance/consequences in the industry. In this way risk is an important factor in the construction industry and its influence and impact only keeps increasing with infrastructure projects becoming ever more complex and therefore more exposed to high risks. (Baker, Ponniah, & Smith, 1998). The risk management is an important factor for the industry and should be an integral part of the whole construction process for both contractor and client. Good risk management practice is a matter of professional reputation, economic performance as well as environmental, safety and societal outcomes (ISO, 2016). This has led to integration of international standards for risk management such as ISO that help companies to manage risks effectively, however, there remains a doubt regarding the difference between bureaucracy and theory versus actual practice in what processes really are being followed. By managing risk effectively organizations are able to increase their performance in this environment full of uncertainty (ISO, 2016).

1.1 Purpose

The purpose of this report is to evaluate how the risk management process is perceived and used, in theory and practice, at different organizational levels within a construction company. This involves investigating the reason for different decisions done by actors and their involvement in the risk management processes. This is done to evaluate how the risk assessment process is structured within such a company, how it differs in approach and impact throughout the organization hierarchy.

1.2 Limitations

- This thesis focuses on the construction industry and will be done through a case study on one construction Company.
- The sample size for the interviews was limited as a consequence of the timeframe of the report.

2 Literature review

A literature review was done in order to ascertain a theoretical background regarding risk management in the construction industry. To understand risk models and how they are selected and used for successful project outcomes and a research into a company's risk organization for elaboration of the general risk management within the industry.
The literature review is twofold and involves an investigation of risk management in general. That is the concept and the general risks that are encountered in a construction company, the benefits of well-functioning risk management as well as its limits. A deeper analysis of risk models, their independent structure and importance in successful risk management. Lastly, a review of the behavioral science of risk-taking decisions is done in order to investigate human aspects of decision-making and the factors that influence it.

2.1 Risk management

Risk management in a construction company is a way to quantify uncertainties in a projects which otherwise might be assumed in early stages of a project and therefore lead to losses in both cost and time (Mills, 2001).

2.1.1 Concept

Risk management is a worldwide concept used in order to make projects more profitable and is a great tool for managers to use for assessing, identifying and controlling risks (Mills, 2001). The risk management process is not a tool to pass responsibility over to another part but to be able to share, control and minimize different types of risks (Kartam & Kartam, 1999). Risk management can be implemented on a whole organization, in distinct areas, on different levels, at any time, at specific functions, projects and activities in a company (ISO Technical Management Board Working Group, 2009).
Usually the risk management goes through four stages (Zhi, 1995):

- Risk classification *what type of risk is it?*
- Risk identification *what could happen?*
- Risk assessment *how severe is the risks?*
- Risk response *how do we manage it?*

These stages are illustrated in Figure 1 below where the arrows are showing how the communication lines should work in a project. To have a fully functioning risk management there has to be an establishment of the context regarding the risk management work. The risks that might arise should be identified. Analyzations and evaluations of the identified risks should be assessed. When these steps are fulfilled, it is time for the treatment of the risks. All these steps should then be monitored and reviewed to find what measures could be implemented for the work to function even better and make sure the designed measures are working as planned. There should also be a constant communication between the different steps to ensure that nothing is overlooked.

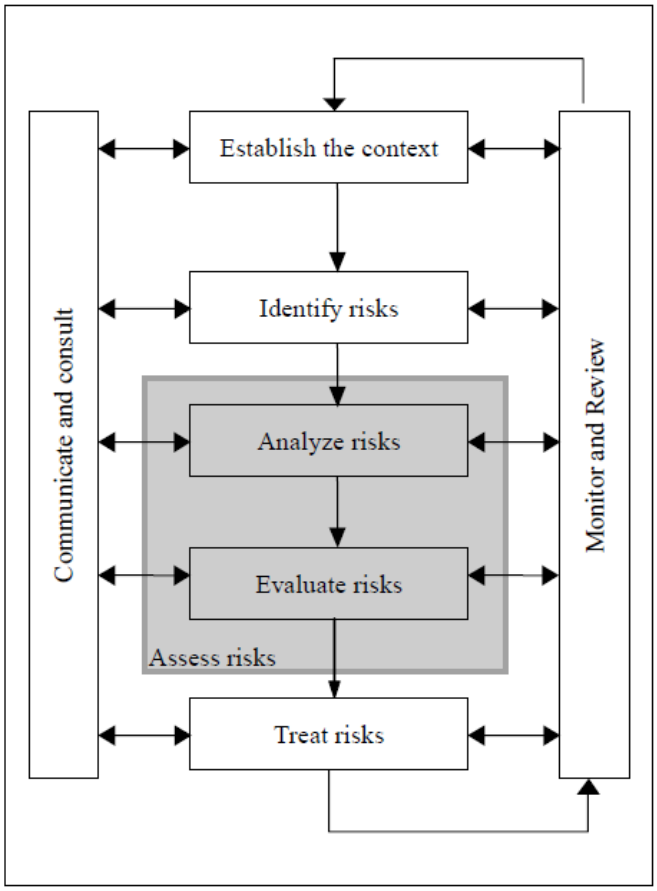

Figure 1 - The risk management process (Amornsawadwatana, 2007).

2.1.2 Risks in projects

The different risks that occur in the construction industry can be divided up in to three different areas and are described by Zavadskas, Turskis, & Tamosaitiene (2010) as being:

- Internal risks
- External risks
- Project risks

The internal risks are such that different parties within a company can undertake. Subcontractors, stakeholders, designers etc. fall under internal risks. External risks are those that are out of the project management range to control, for example weather or politics. Project risks represent those risks that could occur during a project and are associated with time scheduling, cost, quality etc. These three risk-types can be divided up into further sub-categories. A deeper explanation of the different risks can be seen below as according to Fisk (2003).

2.1.2.1 Internal risks

Resource

Resources are what the project needs to function and involve a risk that the contractor should assume exists, for elements such as material, equipment and personnel.

Project member

Here the risks that could occur within the project team should be addressed which could change the outcome of the project. Risks include bad communication, low experience/knowledge in similar projects, team member turnovers etc.

Documents and information

In the tender/production phase, the different governing documents that should be used for the project are analyzed and in some cases, assumptions are done in case of contradictions, to explain how the client wants the work to be done. The risk here is the legal, communication and contradictions between documents.

Stakeholder

The risks that concern the stakeholders should be the choice of supplier and construction method, but beside of those the stakeholders also undertake their own risks.

Design

A construction project depends on a good and functional design to keep time-schedules and budget. As today, the design and construction method becomes more and more important this risk should get more influential. The risk in this area involves concern for technical design, geotechnics etc.

Contractor

The main contractors should have good insight in the risks that concerns them. This could include communication problems where for example sub-contractors do not follow regulations or a delay in the transport of resources.

Sub-contractor

The risk in this area can easily be placed on the contractor and not found in another risk category. The sub-contractor is exposed to the same risks as the main-contractor, 2.1.2, but at their own level.

2.1.2.2 External risks

Political

The political risk depends on what could happen if new laws, regulations, policies or changes in administration systems would occur and thus affect a project.

Financial

The economic area concerns the risk of eventual economic changes such as changes in interest rate, unpaid bills, inflation and funding problems. This can be hard to assess since for example market collapses come in periods with different extremities.

Social

This can involve interest from persons around a project that can interfere or cause problems for the development. This can for example be through public opinion, and situations that could result in worse market value etc.

Weather

The weather is an uncontrollable factor and is therefore a cause for concern. It is however something contractors should be able to factor in as long as an abnormal event does not occur, such as early winter, flooding etc.

2.1.2.3 Project risks

Time

Causes that lead to delays should always be seen as risks, since delays usually result in a direct or indirect cost. In the end, it could make the outcome more expensive than it should have been.

Cost

Involves a risk that the negative output or cost regarding a project increases due to neglect in management.

Work quality

Added work and cost that occurs due to bad production quality performed by the contractor. Liability disputes can come up because of poor work quality which could affect the outcome drastically.

Construction

Changes in the construction phase such as choice of technical solution or method, different sources of delays and other types of alternatives should be assessed in this area.

Environment

This risk concerns the work environment and the corresponding workers at the work site. This area includes physical, chemical, microbiological, psychological, social, organizational, technical and ergonomic issues that could occur during construction (Peab, 2007).

2.1.3 Risk models

Establishing a risk model is an important part of improving the risk management process as it forms the basis for eventual risk quantification and assessment (Zhao & Duan, 2008). Risk management in projects is always affected by various factors that are associated with uncertainties, and imprecise data contribute to the difficulties of selecting a suitable risk model. An ideal risk model suited for all organizations or projects does not exist due to their different characteristics. Several of the problems with risk models can be subjective, where sophisticated quantitative techniques are ineffective. (KarimAzari, Mousavi, Mousavi, & Hosseini, 2011) Many analytical models have been developed to evaluate risk exposure and can be useful as they limit the variables taken into account but that

in return can make them unreliable. These limitations in various models of risk quantification leave a gap for development of new models or systems. Risk models do however provide a qualitative understanding of unfolding events that can become critical. (Walke & Topkar, 2012).
The risk assessment model is the most significant procedure of the risk management in a project and it is up to the project management team to select the most appropriate methodology. In the selection of method, there are some factors to consider, such as (KarimAzari, Mousavi, Mousavi, & Hosseini, 2011):

- Cost of technique
- Level of external parties approval
- Organisational structure and size
- Agreement
- Adaptability
- Complexity
- Completeness
- Level of risk
- Organizational security philosophy
- Consistency
- Usability
- Feasibility
- Validity
- Credibility
- Automation

The risk assessment model involves another two key modelling aspects, firstly the process of collaborative teamwork between different parties aiming towards a common goal of successfully completing a project. Secondly, it is important to keep in mind that the knowledge in the real world is more imprecise than precise. Therefore, the preference information that is used for the model selection can always be inaccurate. Therefore, factors, either quantitative or qualitative, can contradict each other and affect the risk model selection due to this uncertainty. (KarimAzari, Mousavi, Mousavi, & Hosseini, 2011)

2.1.4 Benefits

Risk management does not only involve time and cost factors in a project but is also a way of understanding the problems that might emerge before it is too late, and by doing so the processes can be more easily controlled (Mills, 2001). The quantification done in the risk management is good to have as a reference to highlight the different areas that are in need of further investigation, clarification or design.
It is a good way to show the clients and other involved parties that risks have been taken into account in the project, which might increase the credibility and reputation of both the project at hand and the company itself (Akintoye & Macleod, 1997).

2.1.5 Limits

Risk management is not the solution to all problems but, if the right person with the right experience does it, can be a way to decrease future project losses (Mills, 2001). The project manager should have an interest in the risk management in order to achieve the best outcome.
The more specific and precise the risk management method being used is, the more time demanding and costly the process becomes so it is often a matter of finding a suitable option for the specific project (Akintoye & Macleod, 1997). Risk management is not easily done when assessing risks with an uncertain outcome or possibly solutions are difficult to evaluate. (Besner & Hobbs, 2012). Some risks might be hard to assess in general due to the complexity involved within the risk factor. For example, one such risk could be the risk of adverse weather (Kartam & Kartam, 1999).

2.1.6 Risk management standard

ISO 31000 is an international standard developed by ISO Technical Management Board Working Group on risk assessment (ISO 31000, 2009). The standard document offers advices in how the risk management should be addressed, implemented and controlled in the following areas:

- Overall control
- Strategy
- Planning
- Leading
- Documentation
- Policies
- Norms
- Culture

ISO 31000 is divided up in the following chapters, where the important factors in different steps are taken in to account. The relationship between these steps is described in the picture below, Figure 2.

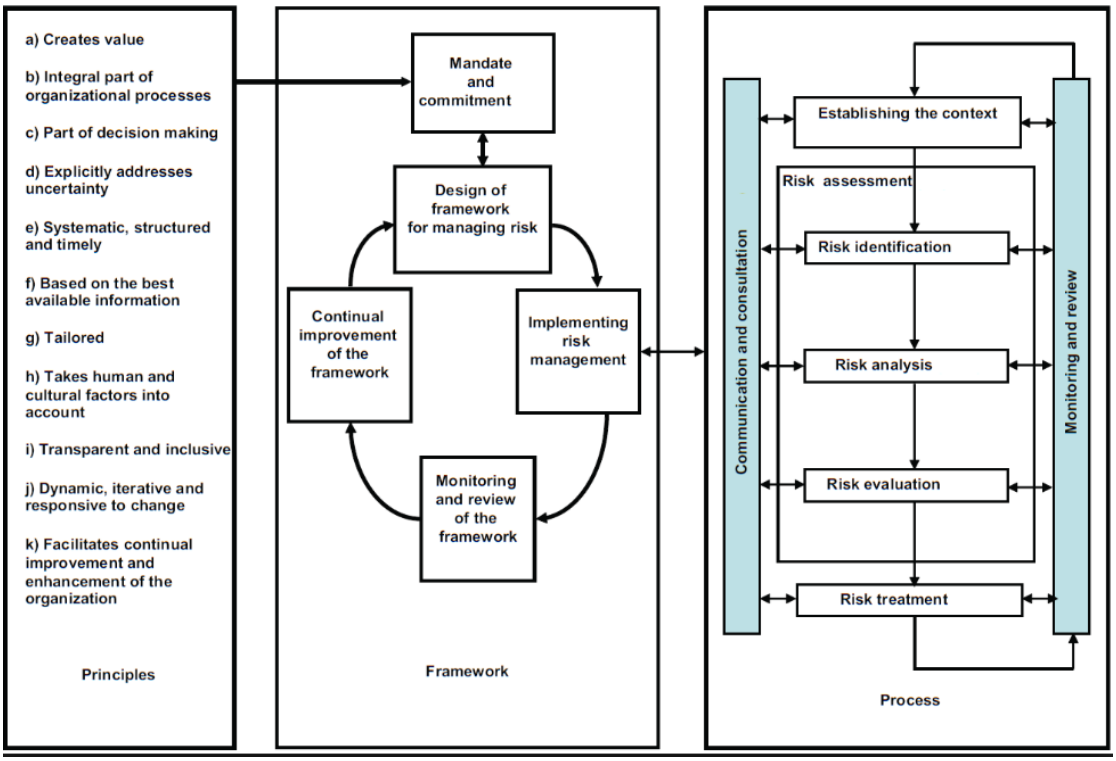

Figure 2 - Relationship between risk management principles, framework and processes (ISO Technical Management Board Working Group, 2009).

2.1.6.1 Principles of ISO 31000

This ISO standard does not involve proposing a specific model that should be used, but rather represent a collection of acquirable procedures that are supposed to make the industry more efficient by putting together a couple of principles that should be fulfilled. Risk management:

- Creates and protects core values

Risk management is working towards successful goals and improvements of performance in terms of how risks are perceived and handled.

- Is an integrated part of all organizational processes

Risk management is not something that should be standing on its own but rather be an integrated part of every process.

- Is a part of the decision making

The key to success is to make thought-through decisions during every project. Risk management is an auxiliary tool to make more decisions that are systematic by prioritizations and findings of new methods.

- Treats explicit uncertainties

The explicit risk is evaluated by the character of the risk and how it has to be managed.

- Is structured, systematic and suitable for the tasks of interest

By keeping it systematic and structured, the risk management can be used as a communicational tool to get feedback in future projects.

- Is based on the best possible information

The data that is used for risk management should be the best suitable information such as:

  - Historical data
  - Experience
  - Observations
  - Comments from experts

The data should be thought through and reviewed concerning its limits and the models used. Comments from experts in the field should also be taken into account.

- Is custom-made for the company that uses it

Every company has different risks with different consequences or outcomes for a project. Because of this, there is no perfect risk model that fits everyone. However, there can be a model that is close-to perfect for a specific company.

- Takes human and cultural factors in to account

The risk management takes into account perception, intentions and abilities of external and internal actors that have an impact on the outcome of a project.

- Is transparent and covers everything

Risk management should be kept relevant and suitable for the task that it is supposed to cover.

- Is dynamic, iterative and can be updated

Since internal and external events could occur that might change the perception of a risk, there is a continuous work to find new methods and techniques for better performance in a project. The risk management should be dynamic and easy to update.

- Facilitates continuous improvements of a company

Companies should have a strategy, which includes how the risk management is taken into account and updated through all parts of the company.

2.1.6.2 Risk framework

A suitable framework for risk management should be developed and integrated into every organization. This framework should include delegating the responsibility of ensuring the risk model is followed and used in a proper way for every part of the project (ISO 31000, 2009). Framework design should consider:

- Understanding of the organization and its context
- Risk management policies
- Integration of organizational processes
- Setting up internal/external communication and documentation methods.

The risk framework should describe how the company perceives the work around risks and how that work is managed. Understand what resources are needed to manage the risks in order to follow through with measures considered suitable. Organizations should open communication and documentation methods to support and encourage the risk management work. Evaluation of risks severity should be standardized regarding the company's interest and the organization should take the risks described in 2.1.2 in to account (ISO 31000, 2009).

Implementation of a framework

There are several ways to implement a new framework or methods such as the un-freeze, change, and re-freeze phases (Bazerman, 2006). When a company stops using a certain model or process it is called to un-freeze. Thereafter there is the change that is used to describe an implementation of the new system. Finally, the re-freeze is the monitoring and review phase to make sure the new system works according to plan.
The ISO standard highlights the following factors as important to take into account when implementing a framework (ISO 31000, 2009):

- Having a strategy and time plan for how and when to start with the risk management process.
- Policies and working processes of the organizational levels in the project.
- Investigation regarding the work so that it is done according to laws and conditions.
- Making sure that the decision-making and the development of goals is done according to the provisions in the risk management.
- Provide informational and educational meetings to improve and encourage further work.
- The framework should be kept suitable and not too focused on trivial things of little or no interest to the project.

The implemented risk management framework should be surveyed and monitored frequently to make sure implemented risk measures perform as expected.
It is incorrect to think that a risk framework can be perfect and not improvable. To maintain a stable and good risk management it should be in continuous development due to the constant changes in internal, external and project-based parameters of the construction industry.

2.1.6.3 Process of risk management

Risk management should be an integrated part of the work and be custom-made for the business process as well as culture and practice of a project. Consultation can be good in the early stages to prepare for risks that might occur and should involve:

- Causes of risks
- Consequences of the risks
- Measures against the risks

A functioning internal and external communication is important to secure that the different risks are being worked with as they should. Keeping up with this communication work can:

- Help establish a suitable context of the management
- Secure that the interests of the stakeholders are being understood and followed
- Be a helping tool to make sure that the risks are identified in a sufficient way
- Let experts in the field comment on how the risk should be assessed
- Secure that different opinions are being heard when assessing the risks
- Improve the risk management work in general

2.1.6.4 Establishment of context for risks

Establishment of context should be regarded in internal, external and project locations to define all the parameters that are involved in different processes. Risks described in chapter 2.1.2 should be evaluated within the establishment of context and the management of them should also be decided in this stage.

2.1.6.5 Risk assessment

Risk identification/assessment/evaluation should be done for different risks to clarify which risks could occur for every project and the severity of their outcomes and consequences.

2.1.6.6 Risk treatment

The risk treatment should involve one or several solution/mitigation methods for different risks to ensure that the most suitable measure is found for all the risks.
A risk treatment is done to:

- Avoid the risk
- Increase or decrease a risk that could involve a business opportunity
- Eliminate the risk source
- Change the likelihood of the risk
- Change the consequences
- Share the risks with other parties in the project

The choice of treatment should be decided by evaluating different solutions and methods so that the most suitable option can be selected. This whole process should be documented for transparency and reviewing. This is done for future projects and eventual updates of the risk management process.

2.1.6.7 Surveillance and audit

A specification of who is responsible for the surveillance and review of a risk should be prepared. That is to ensure that the right person with the corresponding knowledge is working with the risk in question so that a suitable measure is made for the specific risk.

2.2 Behavioral aspects of decision making under risk and uncertainty

Behavioral science is the study of human cognition and behavior. This subject is relevant since risk-taking problems are a pure decision-making problems. Researchers studying this area have come out with that, in general, risks should be rejected in the decision-making when it is seen as a risk and not a gain but several other aspects have to be accounted for as well (Yates, 1992, ss. 1-3).
The risk management is constantly affected by judgements and errors thereof. Research of decision-making has been on the agenda for decades and due to the complexity of the subject will continue to be so (Yates, 1992, s. 29).
Different decision-makers perceive risks differently. A risk that one person considers severe can be seen as "child-play" by another (Yates, 1992, ss. 10-36). Every risk and the circumstance of its specific assessment are different and depending on each other. This is one of the reasons why setting up a project team is important for the risk management process. A well-developed decision framework ensures the right decision is being made on the right time with a coherent strategy to be more aware of biases. This makes the identification procedures for identification and integration of decisions with risky outcomes more efficient (Bazerman, 2006, s. 45). With good decision-making, the mismatches between actual happenings and expectations can be judged in a satisfying way and should be done to minimize surprises. (Eweje, Turner, & Muller, 2012).
Why decision-makers tend to make the decisions they do can be described by introducing the hypothesis "expected utility" and "anchoring & adjustment heuristics". Where expected utility describes the correct action when an outcome is unknown and anchoring and adjustment heuristics describes the parameters that influence the choice of action.

2.2.1 Expected utility

In a decision-making context, the maximized expected utility means that when a result from an action is unknown the action which gives the higher utility should be chosen (Briggs, 2015).
The discussion goes on regarding decision makers tending to make "irrational" decisions instead of "optimal" decisions. That the irrational choice is more frequently made regarding smaller, general tasks while more rational or optimal choices are made when facing important decisions (Yates, 1992). Researchers claim that decision-makers often tend to make "sub-optimal" decisions regarding risks in general when instead it should be the "optimal" choices. For example: Nicholas Bernoulli found out in the "St. Petersburg Paradox" (1738) that gamblers (decision makers) did not decide on the value of the decision but on the utility of the result.
Example: In the tender phase an entrepreneur has two options.
Option 1 has a simple execution with higher cost than option 2. The entrepreneur knows how to execute the project but the earnings are lower. Low risk and earnings.

Option 2 is an execution that the entrepreneur is inexperienced in but he knows that by succeeding the earnings are much higher than the option 1. High risk and earnings.
Which option should the entrepreneur choose? By the use of the expected utility concept, the option with the highest expected utility should be chosen. However depending on entrepreneur's situation, this choice can differ. He/she might have a reliable economy and want to test a new technical solution so option 2 might be optimal while he might also be in a tight economic situation and therefore needs a more secure option and leans towards option 1.
How people really make their decisions can be described by the descriptive decision theory, which says that people make their decisions in a way that satisfies their most important needs, even though there is a lack of information regarding the outcome of that decision (Yates, 1992).
Bazerman (2006) claims that decisions are often made about expected losses instead of expected gains of the risk, which it in fact should be in order to ensure the benefits of the action or decision. For example how the benefits of structured risk management represent a good preparation that more likely results in a positive outcome instead of a more common conception of risk management being time consuming and demanding extra resources.

2.3 Summary

This literature review was done to go through the theoretical aspects supporting the reports result. The purpose of analyzing a construction organization's risk management process at different levels and understanding how risk is both perceived and dealt with throughout it. The report tries to discover a red line running through the management levels and where the responsibility and ownership of risks lies. The key questions the report asks are the following:

- How is risk management handled in a construction company?
- How is it perceived at different levels of a construction company?

3 Method

For research design the strategy and methods chosen depended on the respective subject (Noor, 2008). That is whether the subject was associated with a quantitative or qualitative method of analysis. Where the quantitative method is based on the natural science model of dealing with facts or "true science" and the qualitative implies more focus on processes and meanings that are not measured in terms of amount or quantity. This study was based on a qualitative method with focus on interpretation, insight and discovery from a case study involving research questions formed into interviews. This was done to limit the research scope to a single company. The qualitative findings were then supported by a survey that was conducted on a larger sample scale for greater data collection. The gathered data was then cross referenced with the literature review to support the results and enhance its reliability for a broader scale of the construction industry. In this study the method is divided up into steps to keep different types of data separated.

3.1 Case study

A case study approach is used in order to get an understanding of how and why things happen and allowing for investigation of contextual realities and the differences between what is planned for and what actually occurs (Noor, 2008). Case studies have proven useful when trying to understand complex real-life activities for a particular problem or situation in great depth and can give a holistic view. In this way they are useful in capturing the ebb and flow of organizational activity, in this case the risk management. The risk management work in a construction company was therefore used as a case study by evaluating pre-documented gap analysis of ISO 31000 international standard as well as the authors own research on the risk management principles listed by the company and their client's general demands and requirements.

3.2 Data collection

This was done by looking into the standards and guidelines that the company publishes as their risk management structure as well as by performing interviews with people at different levels within the organization, from different projects. The data collection includes transcript of the answers acquired from the interviews as well as observational notes made by authors.
For additional results and support of previous analysis a quantitative survey was sent out through the company's mail list. A short excel survey was created sent to a wider list of similarly potential interviewing participants, or 64 different managers of which 30 percent answered, to add quantitative data to the results in order to further strengthen arguments and analysis of the aforementioned investigation. The 22 respondents contained 12 site managers, 8 project directors, 1 regional manager and 1 business area manager. In the survey, the respondents were to rank order the 16 risks described in 2.1.2, in terms of their importance.

3.3 Interviews

The interviews were semi-structured in order to get more flexibility when addressing different respondents from different areas so that the interview could stray a little from the pre-designed interview guide. Giving the respondents freedom to express their views while following a similar, standard data collection theme as well as providing reliable comparable qualitative data (Cohen & Crabtree, 2006). Nine interviews were conducted and recorded with individuals at different levels and departments within a construction company. Containing individuals from site-manager (3), project director (3), regional manager (1), business area manager (1) and leading group (1) levels. The interview guide can be seen in Appendix 1. A pilot interview was also done before the formal interviews in order to evaluate and refine the questionnaire and make sure it provided the information it was designed for. The interview sampling was purposive, that is chosen according to pre-determined criteria so the respondents were hand-picked by the aforementioned construction company based on their position and responsibilities.
The interviews were aimed to get an insight into how the risks are perceived and worked with at different levels in the organization. How different people work with risks on a daily basis or project specific. This was investigated to try to get a grasp on if there is a noticeable "red line" regarding what type of risks is present, significant or recurrent and how they are managed and followed through the levels within the company.

4 Result and analysis

The result and analysis chapter investigates the status within the company regarding client demands, current risk management status and work procedures. This includes the response from interviews and the survey that were carried out.

4.1 Risk management in a construction company

A risk management structure is always complicated within a large company with many approaches to consider. For projects and in particular larger ones with huge expenditures there needs to be established a decision making order to prevent large decisions being made carelessly and without the proper knowledge and/or tools. For example, in this case the company has set up a protocol for decision making in the tender phase so that there is a certain way to keep the responsibility at the right levels. This is done as a "safety-net" to make sure that the expensive decisions are made by the correct personnel. A person is therefore only allowed to sign a bid if it is lower than 10% of its respective level yearly revenue, otherwise the decision is passed on to a higher level of the organization. However if the bid goes over 200 million SEK it should go directly to the business-level and if it goes over 1 billion SEK it should go to the leading group-level, see picture below.

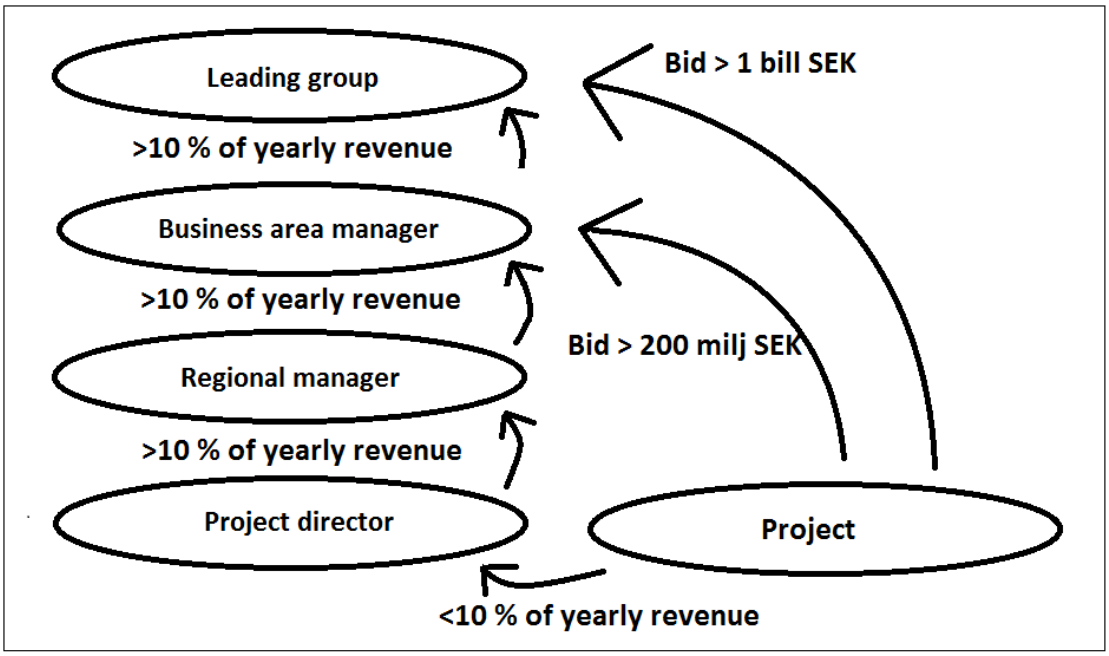

Figure 3 – How the responsibility of the bid is distributed within the organisation.

4.1.1 The case study

The case study was done at a large company in the Swedish construction industry. The company was chosen due to its interest in the subject field and is currently in a development stage to enhance its risk management.

4.1.1.1 Gap-analysis of the risk management process

A consultant firm had been hired to perform a Gap-analysis at the company, which is a comparison against ISO 31000, to find out what the company needs in order to improve their risk management process. This analysis has shown several areas that are open for improvements. The goal of the company is to eventually become certified against ISO and to accomplish this there have to be improvements in the area.
By analyzing the consultant's report some general risk management parts where the company is lacking can be identified:

- Several definitions are being used throughout the organization that have the same meaning and should be revised to have the same definition everywhere.
- The risk management process should be more integrated into the general project work.
- Policy, goal and risk responsibility does not exist at this moment.
- The risk management process is currently done project specific, where the clients demands is the only thing accounted for more or less. This should be more open for opinions from other external actors or stakeholders.
- Risk-owner is currently a term that is not in use.
- Communication channels in the working process are currently unclear and should involve more external parts of the projects.
- The effectiveness of the risk management process should be measured between projects.
- Since the perception of risks might change over time and new techniques might alter the measures used against risks, the risk management should be under a constant development and not "cut in stone".

The company should implement and update the risk management process by:

- Find out clear goals in how to work with the risk management process.
- Responsibilities between the person responsible of the risk response and the risk-owner should be clearly described between projects.
- The risk management process should be integrated into projects with clear routines on how to use it in the daily work.
- Risk assessment methods should be developed.
- Definitions of the risk criteria should be developed.
- A clear risk identification schedule should be made.
- The model used for likelihood of risks should be better defined for improved performance in risk assessment.
- Risk evaluation should be done regularly.
- Risk documentation should be developed to show:
    - Risk measure
    - Cost of risk
    - Likelihood
    - Consequence
    - Risk-owner
    - Cause of risk

4.1.2 Client demands

Different clients in diverse areas all have their own view on how the risk management should be addressed and handled. The ISO standard serves as a basis but since different work is being done for different clients addressing different risks that differ in severity and consequences the routine and methods need to be evaluated and altered accordingly.
In this report three clients were addressed:

- Swedish transport administration

Swedish transport administration is a state administrative in long-sight traffic planning of road-, air-, railroad- and sea-traffic in Sweden. The company is frequently working with Swedish transport administration when constructing or renovating roads/bridges/tunnels etc.

- Internal clients

Internal clients come in in some cases as a client when constructing building foundations/court-yards etc.

- A municipality in close to Gothenburg

The municipality is located in the county Västra Götaland in Sweden and is a client for the company regarding road-maintenance in the municipality.
Swedish transport administration has a risk identification/assessment model that is used for requirements in their projects (Håkansson, 2011). This model is based on how the risks could affect the outcome of the project regarding cost, time, function, environment and client/trademark. First the different risks are identified and then assessed by how severe the consequences are.
The severity is divided up into three cost consequences:

- Min cost *How much will the minimum cost be?*
- Max cost *How much will the maximum cost be?*
- Likely cost *What is the most likely cost?*

Time, function, health, environment, client/trademark is graded by their severity with an example from the health category:

- Grade 1 *Personal damage without sick leave*
- Grade 2 *Personal damage with less than 14 days sick leave*
- Grade 3 *Personal damage with more than 14 days sick leave*
- Grade 4 *Severe injury with permanent damage*
- Grade 5 *Death*

After grading the severity of the risk the likelihood of the occurrence is graded:

- Grade 1 *Very low*
- Grade 2 *Low*
- Grade 3 *Moderate*
- Grade 4 *High*
- Grade 5 *Very high*

The internal clients and the municipality of interest also have a certain way in how they want the risk management to be conducted where the internal clients

have the same requirements as the company while the municipality still is in the construction phase of their demands.

4.2 Perception of risk management

To answer the questions set up in this report the following chapters in the result will go in to how the respondents answered during the interviews and survey. The positions of the respondents were structured as shown below, Figure 4. During the interviews there was a re-occurring answer regarding the company's own risk management process. No one except the business area manager and a respondent in the Concern could really define it on the spot. But there was a coherent response regarding the company´s crisis organization that it works in a way that has a high satisfactory level among the respondents. They have trust that this department can step in and help in a crisis situation.

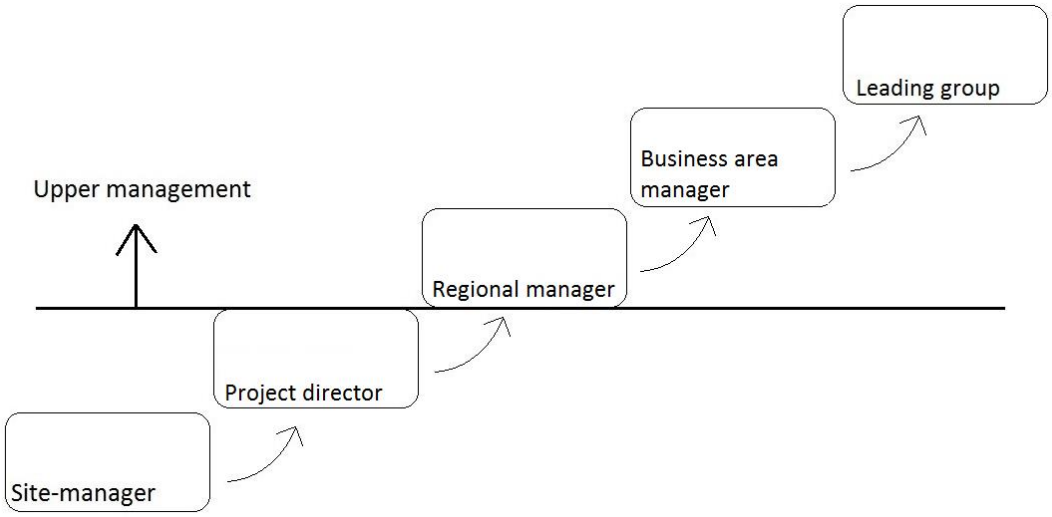

Figure 4 - Description of the different respondent's positions

The respondents from Regional manager and higher are considered as "upper management" to differentiate their answers and valuation in the survey versus the managers on the lower hierarchic levels. This was because there are fewer managers at the higher levels. The concept being that this way the results from the survey become more apprehensible and better to analyze. The interviewing result is still divided up between all the hierarchic levels to give deeper insight into risk management functions and views at different managerial levels in the organization.

4.2.1 Managers´ risk perception

The risk perception chapter looks at how different risks and the risk management process are perceived at the different levels of the company with regards to their personal opinion and views taken from interviews.

4.2.1.1 Site-manager

During the interviews the respondents, representing the site-manager level, had a continuous response that work environment is a highly focused topic. Since this area could be the difference between life and death in some cases. The work environment topic is affected by several areas in different projects, with mostly

stick-injuries and eye-damage but also precautions against severe damages. It is always concerning talking about putting money on this type of risk since it, as said before, could be a question about life and death and no one wants to put value on life.
The risk management process is applied as directed from the organization management where economic risks are under strict hieratical order while the work environment is mostly dealt with at work site.
The respondents have generally a good insight in the project specific risk assessment area. It was noted that risk assessment has received increased attention over the past years. Where maybe eight years ago you could excavate until it seemed unstable, nowadays you have to make sure there is no risk of mass landslide for example. It is the respondents' perception that personal experience and client demands are the most influential factors when working with the risks management.

4.2.1.2 Project director

Risk management is considered to be a large part of the project directors responsibility. There are big working environmental risks involved in the projects and according to one respondent the most recurrent risk involves the traffic environment in roadwork and railroad projects. There is a constant risk with traffic, where there are several alternative solutions and one can never be 100% risk free. Every year there are a few incidents where someone has crashed into the safety barriers while people are working.
Internal risks are frequent as well, which can involve specific requirements from the client being misunderstood or not successfully managed in the calculation stage and therefore their goals have not been met. Another example of a present problem is that personnel in certain projects quit, especially during longer projects, which usually results in worse results. That the site-manager leaves for another company could happen several times during the lifespan of a large project and suddenly there is no one who has an overview or control of the project and what went on in the early stages.
The project director is also responsible for the work environment, which he delegates to the site-manager, but from there it cannot be delegated further down. This includes responsibility for work preparation planning with the workers that involves risk analysis for work operations. The work environment plan, AFS, and the 11 risks there are the basis for the risk management in the work environment part. It is a quite controlled area due to legislation and there are only some risks that are represented with limited types of methods to control them.
Documents and guidelines are structured from experience so the internal process is a result of gained experience from accidents or incidents that happened or were avoided. There are work preparation forms that should be done however these tools cannot be too complicated otherwise they will not be used. There could be a better systematic or formalized way of feedback as today there it is often based on event. Where experience and gut feeling from dealing for example with supplier or a product play a large role in how much or if there should be a little more resources put into it.

4.2.1.3 Regional manager

The most frequent risk dealt with at this level are the economic risks described in 4.1, that the company's competence and proficiency is lasting. The construction industry market looks set to be exceptional for the coming ten years but then the question is if there will be sufficient resources and capability to continue. There is also an economic risk in that the earnings are less compared to the output of work and cost. Ethics is also a risk that must be taken into account here. That the company does not do anything that is ethically wrong which can result in bad publicity and reflect badly on the brand. Regarding risk management in general it is also clear that the client demands is a highly rated factor affecting the decision making.
Risk management can also be a way of "using the handbrake" to help realize if there is no more capacity for additional projects despite a favorable market. As an entrepreneur, there are always evaluations and risk-takings. The risk management can in this context be used for finding both risks and potential benefits. As a regional manager put it:
"It is very much risk-taking for a really small profit."

4.2.1.4 Business area manager

Risk management is a very important part of the work and at the business area manager level there has been an initiative to make the working process more clear. There is a continuous work regarding the larger tenders, especially those that had a negative outcome, to see if there were any specific mistakes made in the risk management. That way it is possible to document those instances to be better managed in future projects.
The work regarding risks at this level includes overseeing the business side and analysis of that area. The absence of routines and delegation of responsibility is currently being worked on for the risk management. Several clients require descriptive documents on how risk is managed and therefore an internal management system is needed. Today there is no comprehensive plan or policies ready but mostly project specific management, which is not ideal. There remains a problem here that clients do not necessarily follow the same rules as the industry so they can each have specific demands of documentation. That results in a lot of effort put into each individual client or project instead of a comprehensive system so there is a need to work more in this area.
The most frequent risks occur when there are modifications from the normal work-forms or documents, which often vary. There are so many different entrepreneur forms today that it is hard to manage and a big risk is to miss something when analyzing the documents trying to find all the extractions in the given information. A lawyer works reading thoroughly through documents trying to find legal risks and other errors done by the client. Even when looking at the same large client the documentation can differ from one project to another. They can also include things that are unnecessarily difficult to estimate. Something that is only possible to speculate in, which makes it impossible to price accurately and reflect reality.

4.2.1.5 Leading Group

The management of risks depends on how it is affecting the results or trademark of the company and is then carried out in appropriate way. The parameters regarding viability, co-workers and the brand are the ones governing the priorities the most.
Some risks are frequent and easy to grasp, such as work environment. Other risks are harder to estimate. One such risk is the succession risk, which is the risk that there will not be anyone to fill a position in the company if someone leaves. That risk depends on what capabilities the company has to replace a staff member for a specific position, in case of a team member turnover or retirement etc.

4.2.2 Survey

A survey was conducted to see how different risks, described in 2.1.2, were ranked based on the managers own view and understanding. This ranking was structured depending on three different viewpoints: The organization as a whole, project specific and from a personal view, how they themselves experience it.
As seen in Figure 5 the perspective on the valuation is similar for the risks between the different types of viewpoints. The risks that had higher variation in valuation were project member, stakeholders, contractor, sub-contractor, political, financial, social, weather, time, work quality and construction.

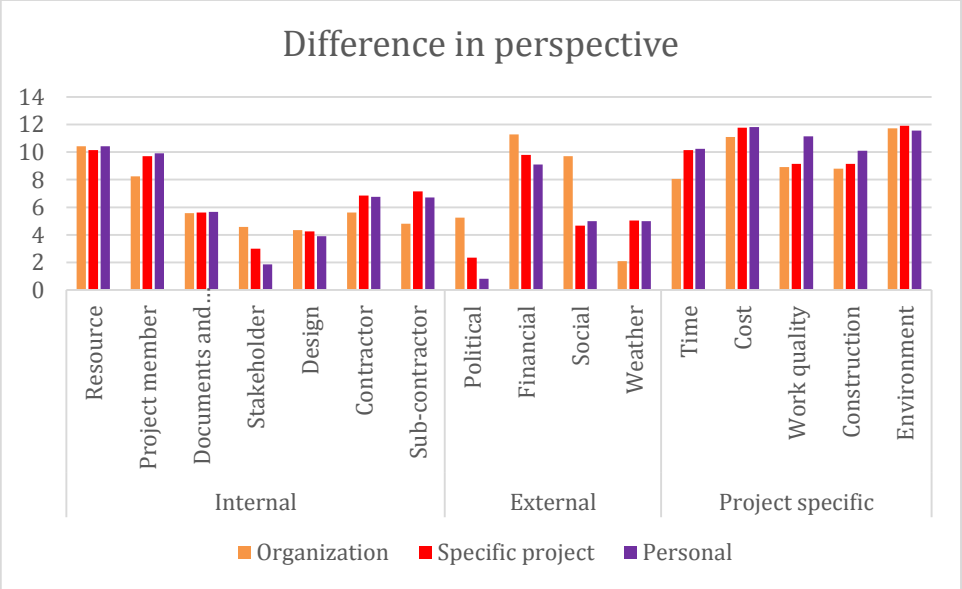

Figure 5 - Difference in valuation between the different perspectives Organization/Specific project/Personal

Project member, contractor, sub-contractor, weather and time can be seen to have lower value from the organizational view compared to the other perspectives i.e. project specific and personal view.
Stakeholder, political, financial and social risks however were higher valued from the organizational perspective. This could be explained by the fact that these risks may not be considered to have a big impact on the specific projects and from a personal view it does not involve the person day to day work.

4.2.2.1 Valuation depending on perspective

To examine these rankings further the risks were divided up between the three major-categories, described in 2.1.2, as well as dividing up the different positions of the respondents i.e. Project-manager, project director and upper management to better understand the difference in the evaluation. This can be seen below in Figure 6 to Figure 8. The valuation including all the different risks is shown in Figure 10 to Figure 12 in the appendix.

Organizational perspective

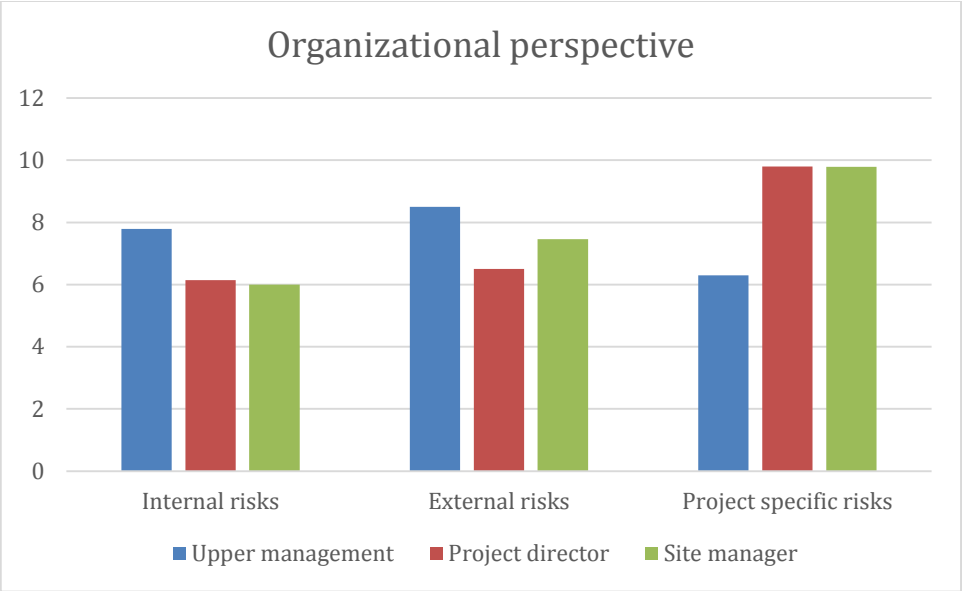

Figure 6 - Valuation seen from the organizational perspective

For the organizational perspective, seen in Figure 6, the upper-management level puts a higher value on the internal and external risks and a lower value on the project specific risks. The project director and the project-manager have a similar valuation where they put higher value on the project specific risks in comparison to the internal/external risks.
Project directors and project-managers value the project specific risks higher but besides that there is little difference between the general valuation of the external and internal risks, from this perspective.

Specific project

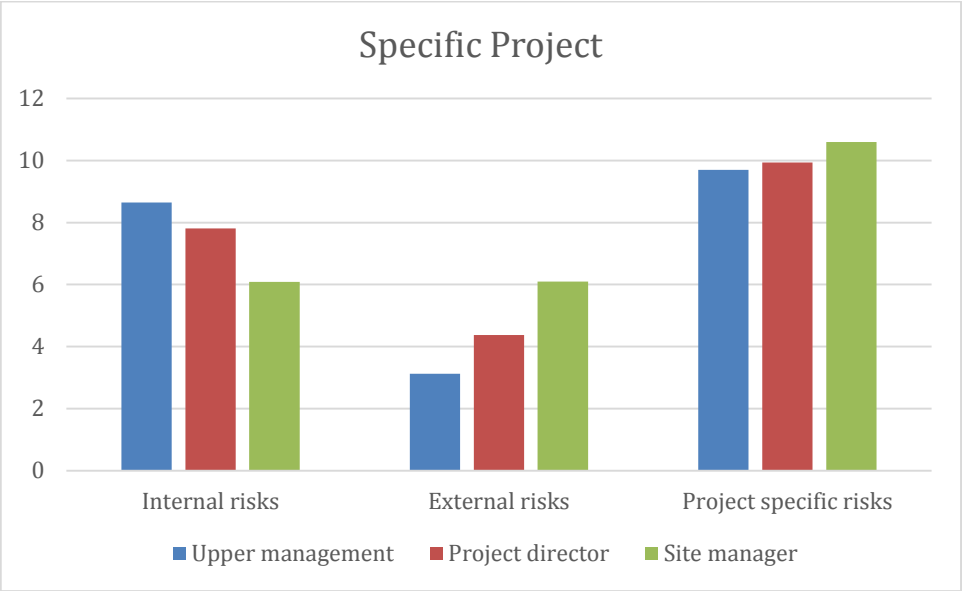

Figure 7 - Valuation seen from the specific project perspective

For the specific project perspective, seen in Figure 7, there is an apparent difference in the evaluations for the external and the internal risks where the upper management respondents have rather high value on the internal, the project-managers however value them lower and the project directors lie in between. The valuation for the external risks are then quite low from upper-management followed by project director but is higher valued by project-managers who put same importance there as the internal risks. The project specific risks are then similarly highest valued between the different positions of the respondents.
Project specific risks are higher valued throughout the specific project perspective while external risks have been the category given the lowest importance by the respondents. The internal risks are still highly valued where some risks included are of concern such as team members and resources, which is important for the project itself to work. The external risks are given the lowest value in this perspective.

Personal perspective

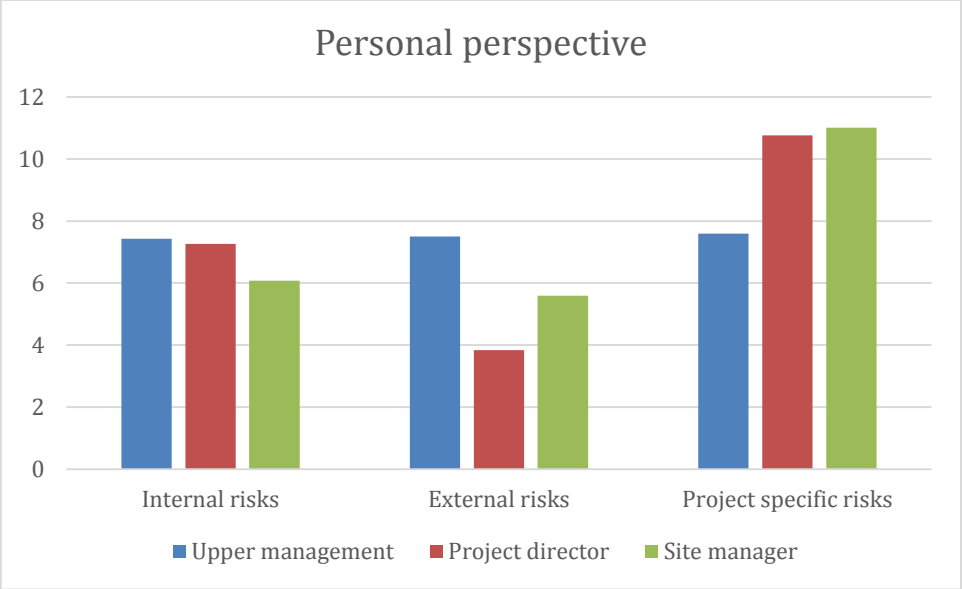

Figure 8 - Valuation seen from the personal perspective

The upper-management respondents had a same ranking between all the risk-categories. The project directors valued the project specific risks highest, external risks lowest and internal risks were given a valuation in between. The project managers ranked project specific risks highest while the internal and external received a similarly moderate value.

4.2.2.2 Extremities

The mean values of the respondents' answers were then evaluated from the risks that were the most decisive, highest and lowest. This was done by comparing the mean values of those risks independently of perspective or position of the respondents. Resources, financial, cost and environment were the four specific risks that were highest ranked throughout the survey. Stakeholder, financial, weather and environment were the four lowest valued risks, seen in Table 1 - Mean valuation of the different risks

Table 1 - Mean valuation of the different risks

RISK	MEAN VALUE
RESOURCE	10,33
PROJECT MEMBER	9,29
DOCUMENTS AND INFORMATION	5,62
STAKEHOLDER	3,14
DESIGN	4,16
CONTRACTOR	6,41
SUB-CONTRACTOR	6,22
POLITICAL	2,79
FINANCIAL	10,06
SOCIAL	6,46
WEATHER	4,05
TIME	9,48
COST	11,56
WORK QUALITY	9,73
CONSTRUCTION	9,35
ENVIRONMENT	11,73

As the table shows, there is clear difference in how some risks are perceived and valued. It shows as well that managers are rather universal regarding the importance of the higher valued risks as the mean value reads high considering the highest value of 16 and the same goes for the lowest. It can also be seen from the table that the lower valued risks are more of an uncontrollable nature for managers which may result negatively on their ranking value i.e. weather or politics.

4.3 Risk management

The risk management chapter investigates the risk management at different levels of the organization gathered from the interviews.

4.3.1 Risk management at specific levels

Personal experience and team discussions are used in projects to identify, assess and review risks that may occur or already have occurred. Regarding environment, this can be everything from a reminder to take a water-sample to assessing if there is any need for safety ropes in a specific operation.

4.3.1.1 Site-manager

A site-manager is regarded as the risk-owner in most cases, especially considering work environment and related issues at the work site. The risk management regarding work environment follows in general the company's own systems how the operation should be managed. This subject is as well influenced by rules and regulations as much of the work is following directives from the government such as the Swedish governing documents (AFS) which is a document regarding organizational and social work environment.
"We do it all the time, all we do is to evaluate risks from risks/opportunities to, for example, earn money to what is most significant is perhaps the work environment and evaluations surrounding those risks."
The economic risks are mostly handled in the tender phase and as a check-up in the quarterly reports. In the tender phase risks are often dealt with by estimating how much money a certain risk might or will cost. In the quarterly reports, the economic side is reviewed to see that the planning and work in general follows the projected costs. The risk identification and assessment is mostly updated during several safety inspections done for projects.
The work leader conducts the risk management, analysis and evaluation that should be updated for every new working moment, except in repetitive work a standardized form can be used. The site-manager is then responsible for the work preparation or delegates it as well as a safety prognosis and quarterly prognosis for the economic risks. At the work site The HSE/site-manager/work leader makes the judgement which work moments should be defined as a risk. The projects are usually manned in a way so that there is more than one person that has control of what is going on at the work site. This is done to make it less one-dimensional and that there is always someone to give support in decision making context.

4.3.1.2 Project director

At this level the risk management revolves a lot around fulfilling the client demands regarding risks they may face and an internal follow up around them. Making sure others are on top of the risks they are dealing with but work less with such risks personally
The risks in the work environment are more for the site-manager to manage while the project director has more of an overviewing role. Then the economic risk can lie at the project director levels where assumptions are done in the tender process, which are then sent down to the site-manager. That way the project can be driven in a specific planned direction. The economic risk therefore tends to lie at a higher level, the speculations and such while the work environment is more at the site-manager level.
In the beginning of the tender process the risks is first evaluated in terms of cost and available resources for the project. The bid is then sent to the project director that assesses the risk and decides to proceed or cancel the bid. The most frequent day to day risk are therefore a lot connected to the tendering processs of projects, where the economic risks are being assessed and handled all the time. There are large control systems that are focused on the economics that serve as the basis for this work. Where all invoices and bills come in and activities so there is a control of the risks and in that way all risks are connected

to the economics. There is also a risk that the project does not progress according to the original time schedules. Due to the amount of actors involved in the projects and the complexity within it can have expanding consequences. That can add cost that has not been taken into account in the calculations and is hard to plan for. If there is a foreseeable complicated technical problem then the estimators, in some cases, try to factor that in by expecting worse production with maybe only 75% work capacity, changing from 8hr day to 6hr day for example and change the pricing in these cases. There is always a risk of an error in assessment of capacity and that is a critical moment to foresee. The work site environment can cause complications with excavations and such in constrained areas and experience plays a big part in decisions around these. Risks in such processes should be captured in an early stage.
The risk evaluation process is something that is prevalent through the company, on every level, in several stages. There is no direct structure but there are daily discussions going on. Some processes have to cost money and take the time it takes. Prediction errors are a concern since there are examples of projects where a big risk was taken and severely backfired. The problems that emerge are often the results from a faulty risk-evaluation
A risk management decision involves a discussion based on what risks are found in the specifications and quantity list in the tender process, where different evaluations are taken into account and where the most economically advantageous solution is sought after. It is based a lot around money.

4.3.1.3 Regional manager

The risk management is a big topic in the tender review where there has to be certainty that the risks encountered so far are dealt with appropriately. This is at least done in bigger projects since risks are usually more significant and cost much more in these cases. Often a risk and opportunity list is done where the risks and opportunities are evaluated, assessed and summed up as a money value.

4.3.1.4 Business area manager

There are formats in the system that should be worked after. However, obviously when putting prices on large projects, the risk identification work is done based on experience and the same goes with the risk assessment. It is clear at this stage, that experience, together with functioning routines, plays a large part.
"Gut feeling is occasionally used and sometimes it works well and sometimes it works badly."
It can be hard to pinpoint which factors influence how the risk work is done since it differs from one case to another. In some cases, clients have really strict requirements that involve a lot of work for a specific project and there their demand weighs the most. In other cases, clients have less strict descriptions and then it is managed in another way. Risks that are of big concern today are regarding documents and information. There are so many types of entrepreneur forms and the clients tend to do changes from the regular documents that control how the management and responsibility is supposed to be for the risks.

The risk management is dependent on the size of the project and the one responsible is always the project-manager or site-manager that has been predetermined. Often there is also someone working with HSE (health, safety and environment) that works with those things. Nevertheless, the main responsibilities are with the site-manager. There has not been a definition in use regarding who is the risk-owner. Today you can say that the line (site-manager, project director, regional manager, business area manager and concern) has to take responsibility for it to work.

4.3.1.5 Leading Group

According to a respondent, the company as a whole mostly follows the determined guidelines from the upper management. Regarding risks, the manager that has the suitable responsibility level and is best suited should be considered the risk owner for that specific risk. There is a never-ending work relating safety as well as physical and psychosocial health for the workers.
The leading group in the company goes through thorough risk identification once every year to find out which risks are of most concern for the organization. This is done with an external consultant for an expert opinion on the subject. The risk response becomes quite abstract when hovering on 12 heavy risks in a big company like this. From there the parts concerning lower organizational levels are mediated to the business side. The responsibility then lies with the business area managers to see through that this is spread further down the line.

4.3.2 Documentation

In the tender-phase the estimator, project director, building contractor engineers and the site-manager document the risks that are found or might occur in a project. This includes the risks being weighted, what they involve, a price estimate and even assumptions of what they might cost in the end. This list is then presented to the site-manager if or when the construction of the project starts.
In projects HSE personnel, site-managers and work leaders do the documentation. In general, the suitable person depending on who owns the risk and the type of the risk should do the documentation. The site-manager is however responsible that the documentation of the risk management is done. The site-manager follows this up in his prognosis, the economics of the on-going project and reporting of accidents or possible risks. Incident reporting is crucial to be able to reduce the probability of the risk in future projects.
Updates of the risk assessment/identification should be done for every new moment in the construction phase. This should therefore result in continuous work so new risks are being taken into account while those that no longer are present is taken away to make it more of a living document instead of only a paper-product. It is normal that project documents change during the lifespan of the project.
Depending on the client, the demand for risk management is different, how it should be described before the project starts, how it should be managed during the project and how the monitoring and review should be performed.

4.3.3 Monitoring & communication

In general, all factors that are compatible with the core values have to be monitored and documented so that they do not pose a risk. The core values are fundamentally what values the company as a whole decides to follow at a given time and express which are that the company should be down to earth, personal, developing and reliable.
In theory, the risk management is followed up to see it has been done correctly. This should be done through a wider review and there is a system for the internal work review however currently there is a lack of resources in this part. The thought is it should be a running scheme where every site-manager is reviewed, at least every three years, to make sure everyone is working in a correct manner. The internal reviews are done with a HSE personnel and the responsible person in the region. Some larger clients also include their own reviews regarding their projects.
In a project the risks should be reviewed at every stage and communicated to every party involved in order to follow the systematic work environment directives of the company. It is difficult to ensure that all the workers in the "danger-zone" are aware of the risks and what could happen which can lead to unwanted consequences. As one site manager stated:
"There is no reason that I know that twelve workers became jammed by tractor-shovels while those who actually work with them do not have a clue."
For work environment the risk management should be updated for every new work task. A prognosis is made for the economic risks every third months to evaluate if something needs changing, has been missed or if the project is following the project budget. If there is a purchase mistake, it needs to be highlighted in the prognosis, notify that the prognosis may not be enough to work it back on track. The risk identification/assessment is mostly monitored for the project during several safety inspections done, where the risks highlighted in previous safety inspections are followed up as well. Apart from that, the monitoring is done by internal-/external reviews and by quarterly reports. Depending on the size of a project in some cases, the risk owner also does monitoring and reviewing of the work. Feedback meetings are then used to learn what has happened and what to reflect on from previous experiences during future and on-going projects. It is important that all levels of the organization receive feedback from other project mistakes.
The economic risks found in the tender process are dealt with as described in 4.1, which is done to make sure the correct person with the right knowledge is responsible for that specific risk. As one project director stated:
"Risks should be communicated within the areas that they affect."

4.4 Improvements & suggestions

Most respondents had comments regarding areas in need of improvement, which are listed below.
A development issue is that the risk management is regarded differently by different actors in the business, where they have different internal regulations of how to manage some risks, for example helmets and safety goggles. Directive documents should be developed so that different projects are dealing with the

risk management the same way. The new VLS-work (business management plan), that is under construction, should be able to reach out to all the different aspects of the risks of interest.
Another respondent reported that the risk management process is missing a link between the tendering process and the production. For the estimator to get his notes forward to the project site. The company tries to have an entrepreneur engineer involved in the tender process to support the estimator who should then continue with the project to support the site-manager. This way there is a link from the experience of the calculations from what has been noted there regarding risks or problems to a work site. As estimators can work on a project for few months building the project in their mind several times and many concerns, speculations and thoughts do not end up on paper. Only the most important things, a portion, are written down and end up on the work site and eventually taken into consideration.
The calculating engineer could instead sit down with project members once a month, for example, to improve the exchange of information and communication. Both parties may have different views on the way the project is driven forward and having different perspectives can only improve the outcome.
"That is what I believe is the biggest problem, to get that experience or thought process from one person to another. You should have more calculation engineers that are involved in both the calculation stage and the follow-up of that project".
Risk management tools are not used enough. The economic risks are set up together and reviewed but management tools are not really used. Excel and calculation tools are useful but that is about it and there is a lack of consistency in the documentation. There is missing a calculations tool to write better descriptions for follow-ups from the calculating engineer in a running text attached to the calculations instead of being in a separate file using Word or Excel for comments that can be misinterpreted leading to errors.
It could be good to have a risk-/opportunity list on every project that sums up the pluses and minuses of the risks in the last row so it is visible. This is not the case today for every project but is something that is being worked more with in the calculations for the bigger projects.
Communication on risks should be done more thoroughly through the organization with more integrated feedback from previous experience so that risks will be handled better in the future or in other ongoing projects. All incidents and accidents should be compiled and sent up to the region management, which then should send it out to ongoing projects so that they get informed about them. That way the experience of what happened is spread out.
It is important to document all types of risks and decisions to be able to do a proper follow-up on even small subjects. For example, documentation regarding accidents without individual harm is inadequate in some projects. That area needs improvements since several decisions are made directly in the moment when the risk occurs. There should be more resources put on internal reviews so that the risk management work can be followed up in a better way. Also there is lacking a real system for documentation and internal reviews at the higher levels of the organization.
There is no systematic work done except for the most recurrent accidents and cost incidents so there is room for improvement there. The incidents that have occurred are presented on project director meetings and should be reflected on

and reviewed during them, however they are once a month. There is little or no overview showing that this type of accident has happened that many times and as a preventive measure, this should be done.
The work regarding succession and how to fill up working spots if someone were to be exchanged due to some reason can be better, there is a working strategy regarding it but there could be more work put in to this topic.
One good thing is that there is an ability to become better. Just as all other companies it is possible to work more with preparation procedures for different processes to get more insight in the work before it starts. Find risks before they emerge. There is a potential to become better, especially with risks regarding work environment since it can result in injuries and is an area highly directed from a law-/regulation-perspective. A organization should not be lacking in these areas and it is important to control that everyone is working as they should. However, it is possible to educate within in the subject.

5 Discussion

As has been stated, risk management is a broad subject that has rather recently come under increased scrutiny in the construction industry. Companies are getting more involved with the complex nature of risk management and the multifaceted requirements from clients that are also adjusting to the change in environment regarding their own roles with stricter demands and regulations throughout the society. This means managers need to adjust to this increased focus on risk management and their roles in documenting and handling of risks in a correct manner, which is an aspect that has been changing quite a bit in a short period. This along with that larger companies' often have slow progress of adopting new processes plays an integral part in what can feel like a lack of a proper comprehensive system and methods regarding risk management. Perhaps most notable regarding documentation and review work. This report shows that the risk management process is a work in progress as the environment is constantly developing companies have to work on improving and adjusting their procedures and systems.

Information is vital for optimal decision-making and although experience plays a large part in good management, a structured, methodological system should be interlocked with all risk management decisions for the best result. The general approach regarding risk management has been the reductionist approach, which is not looking at the holistic picture as a first step; this has proven to produce poor results and can limit the projects quality (Serpella, Ferrada, Howard, & Rubio, 2014). As an example of this, in most cases risk is handled through the application of money or time that is not based on a comprehensive analysis of the risks that can affect a particular project, and therefore in many cases are clearly insufficient to cover the consequences of risks that do occur during the project. Projects then usually end up with costs overrun and becomes delayed. From what has been gathered through the interviews this view has been further supported within the managerial perspective.

Managers also tend to relate risk mostly to the negative aspects instead of seeing it as a potential benefit. Good decisions should be made with consideration of the possible utility included as well. This has been emphasized in literature and according to (Serpella, Ferrada, Howard, & Rubio, 2014) risk management in construction projects is full of deficiencies that are affecting the project management effectiveness and in the end the project outcome.

5.1 Interviews

As seen from the interviews risk management is clearly viewed as an important topic throughout the management levels. Individual managers throughout the organizational levels understand the connection between risk management in the early stages to a better project outcome. However, there is also evidence of disregard in terms of how the risk management is exactly handled or worked with. Pre-designed documents or checklists and 'work structures' for these processes are in need of a shape-up and do not seem to achieve their goals completely. The interviews and the pre-designed documents currently used indicated as well that classification-/identification-/assessment processes in projects can differ unnecessarily as the risk management is very project specific

driven, instead of comprehensively. Although as long as the risk management takes the crucial aspects into account this does not have to give bad results, the whole process takes more time and work than it should. However, this is something that has to be worked with in unison with larger clients or the industry as a whole since companies are of course required to fulfill their client requirements.

It can also be seen from the interviews that there is some breach in communications from the organization to managers as there were very few respondents that could describe or explain the organizations general model for risk management (Question 6, Appendix 1). This as well as all the general topics should ideally be revised in a course every once in a while as a reminder where it can go through how the risk management work should be performed and what should be considered to both sharpen and broaden the personnel's knowledge within organizations. This would give better insight in the area and make the work more clear and progressive. Interview respondents also took up the point of broadening the internal risk management knowledge.

The highest concern in the risk management was found to be clearly related to the safety of workers which majority of respondents said heavily influenced their work in risk management. As one site-manager said:

"*The workers should be able to come home un-injured when the working day is ended*."

That is the risk regarding work environment which is also likely what most can relate to since it is one of the most frequent risks that respondents are facing day to day. The other big focus was regarding financial risks or cost which is another factor that many of the respondents are working closely with on an everyday basis.

The risk management results show the lower levels of the hierarchy are more mindful about how the work site risks are worked with and controlled while the higher you get in the organization the focus gets wider regarding the presence and consideration of different types of risks. The succession risk as an example, where the site-manager is supposed to have good control on his project group and the project director is supposed to have a good insight and manage successions in the different projects he is responsible for. Then the higher management (RM, BM & LG) looks wider into subjects such as gender proportions or mean age of different working groups and so on. There is a clear indication of this observed from the interview results as to how the higher management levels have a wider scope of risks to consider in their work.

Risks are supposed to be dealt with in the area they affect and owned by the appropriate person with the right knowledge and experience. In these types of construction companies, the responsibilities start at the top of the organization and then become delegated downwards thru the management. This is so that the work with different risk subjects is done at the correct level, described in Figure 9 below. The results have shown there is no one that really "owns" a risk but instead the risk travels higher up in the hierarchy when it becomes uncontrollable at the level it appears. The daily work goes through more project specific risks for the site-manager while the rest works more with organizational risks.

Figure 9 - Risk responsibility/pathway

Luis Garicano writes in his article (2000) that in these kinds of organizations (with knowledge-based hierarchy) individuals tend to ask directly a person that knows how to go about solving a problem instead of learning it themselves. The most common or straightforward risks to deal with are usually located at the production level while the more unusual and difficult risks are handled at higher levels. Risks are then passed on higher up the hierarchy depending on the how hard they are to solve (Garicano, 2000).
This way of dealing with risk management works best if there is either, a strict explanation as to who to send the risks to or how to deal with them at every specific level. Otherwise, the process of solving it will take longer time and as said in 2.1.4 becomes more expensive than it has to be. For a private company it is a lot about long-term profitability, all risks that are presented in 2.1.2 can be looked at in monetary terms and there has to be a clear structured and systematic working process to keep this economic result positive.
Subjects that should be worked on for the risk management process to improve are suggested as follows:

- Introduce leading documents that help explain what to do.
- Educate managers in how to work with the subject.
- Make sure that there are enough resources for people doing internal audits so that there is functioning review system ensuring people does their work and decisions correctly.
- Communication channel between estimator and work site.

Most respondents voiced opinions on the risk management and the work process around it. Where it could improve, looking from personal experience or as an organization. This led to a rather extensive field of improvements result chapter. This shows both that managers are well integrated into the process of risk management and that the work procedures have room for improvement and development within the organization. It is a constant question of catching up to

the changing environment and although the risk management in general is considered to be up to standard the structure around it, communication between organizational levels, reviewing, documentation etc. can be considered to be lacking in parts. Such as gathering and storing the data in an accessible form for managers to follow up and use as helpful information in ongoing or future projects. Several valid points were raised during the interviews that perhaps could be taken into consideration for future development as this platform allowed managers within the company to voice their personal and professional opinion

5.2 Survey

Possible reasons for the ranking distribution, seen in Table 1, could be that the highest valued risks are those that are most involved in the daily work of the respondents while the lowest valued risks are those that may be infrequent or do not have a big impact on their work. As described in **Error! Reference source ot found.** this valuation may be due to that the construction industry is anchored by projects that did not have a positive outcome and the corresponding reasons for that. With increasing restrictions for the environmental risks as an example, this area takes a lot of time and demands more energy of the construction industry. The same can be said with cost and financial risks that are more of a "direct" economic risk with direct links to the project of interest. By that, it might be easy to connect this risk-category to the every-day work. Resources are a wide risk category that takes in everything from how the steel price will develop to uncertainties with personnel for future projects. It is important to have good knowledge and information about this to keep time schedules and prevent cost risks to develop into a problem.
By looking at the lower-valued risks, the reason for their valuation is likely due to several factors. The stakeholder risk is more of an indirect risk for a project since the stakeholder himself holds his own responsibilities regarding risks and does not have so much to do within a specific project. The design risk is a risk that often can be controlled since the designer himself should be the one responsible that the construction will work. Both weather and politics are uncontrollable risks and have to be taken in to account and dealt with when the actual risk occurs.
The valuation done for the organizational perspective, seen in Figure 6, shows a more evenly distributed valuation by comparing the different major risk categories together. By looking over the different types of risks, all of them are of importance for an organization. However, for a construction company like this, with such exposed nature of the work, some risks have higher importance than others do. An example of this is the work environment risk that has been highly ranked throughout the different viewpoints, seen in project specific risks in Figure 6 to Figure 8 and environment in Table 1. The external risks that are given the lowest value in the specific project perspective, is as shown in Figure 7 a risk that does not have such a big impact on the specific project since this is more for the organization as a whole to control. The valuation done regarding the personal viewpoint might be the perspective where the risks that come first on top of the mind become more important, see Figure 8. By looking at the specific

project perspective in general all the risks that are of concern for the very production is of interest and less those that do not have big influence there.

5.3 Limitations of the result

The different perspectives might not change the opinions of the respondents' answers, as they should. They might not change their opinions regarding what value a specific risk should get. This might be a small source of error but due to the amount of answers and significant difference between valuations, seen in Figure 6 to Figure 8, we can disregard this factor.
The results gathered from the interviews are limited by the factual knowledge of the respondents, that they know enough of the different parts of the subject to give thought through answers to the questions and not guesses and their assumptions.

5.4 Conclusion

The results and findings of this report are based on a case study performed within a single large Swedish construction company. However, companies compete for the same projects, with same risk management demands from clients and directives or regulations from governments. As the case study research was formulated around a relatively large, highly rated company in a very competitive environment it gives an indication of the level at which the industry is at looking at a wider context. With employees, moving between companies there is personal experience from management structure throughout other organizations in many cases which gives managers insight into that comparison as well. The clients are the same within the market as well which sets the standard of requirements contractors have work with. It has been noted however that there is a lack of cooperation between companies and clients in the risk management structure within the industry. A generalized setup through a more comprehensive system would reduce the work process between projects at the same time as enabling companies to learn from each other and improve communications between similar projects. There seems to be some confusion regarding the requirements of risk management for projects and some pointed out that clients seem to be unsure what they are asking for themselves in some cases. The quality of the work is usually limited to the financial output put into a subject. However, when risk consulting is needed, the lowest bid is usually accepted, as with most other things. Low cost can then come down on time and resources that can result in a lacking analysis. This leaves the contractor having to follow an under-developed risk management scheme. Considering risk management, it is ideal to ensure the quality of the work for more industrious outcome for all parties involved.
The risk management process is rapidly improving and higher management levels are focusing a lot of effort in order to develop better systematic work methods. Responding to the changing environment and demands in the modern society, construction companies are working on integrating risk management into every aspect of their organization as experience has also shown results in improved outcomes.

Risk management is unlikely to stop developing since there are always ways to come up with easier and more environmentally friendly procedures with more economic benefits or simply added safety. The risk management process is just one of several ways to find these methods in a structured and systematic way with insight in the risks that follows.
There is much built-in culture and less systematic structure. Ideally, these can intertwine. Too much systematic structure might produce an unnecessarily amount of information, that only becomes a paper product, while a system with too much culture might become too unsecure with several areas lacking in systematic structure.

5.5 Questions to address in future studies

The nature of this subject is wide and complex as everyone interacts with risks in different ways and/or with priorities, with different angles to look at for specific projects. Due to this, there might be a reason to make a similar study and look into one specific risk or one of the major risk categories with a more narrow perspective instead of all together, described in 2.1.2, and how they are managed.
A study regarding the variance in ranking of the different types of risks between client and constructor is also a topic that could be of interest. To see if the focus and demands set by the client are equally valued and perceived by the contractor, which could be beneficial for adjusting a risk model.
Another area that is of interest is the difference between construction companies work regarding risk management. Different types of construction companies could be investigated and compared. This could show if there are specific areas that the risk management differs between them and how they could benefit each other.

6 References

Akintoye, A. S., & Macleod, M. J. (1997). Risk analysis and management in construction. *International Journal of project management*, 31-38.

Amornsawadwatana, A. A. (2007). A review of techniques for risk management in projects. *Benchwarming: An international journal*, 22-36.

Baker, S., Ponniah, D., & Smith, S. (1998). *Techniques for the analysis of risks in major projects.* Retrieved 1 21, 2016, from http://www.jstor.org/stable/3010665?seq=1#page_scan_tab_contents

Bazerman, M. H. (2006). *Judgment in managerial decision making.* Hoboken: John Wiley and sons Ltd.

Besner, C., & Hobbs, B. (2012). The paradox of risk management; a project management practice perspective. *International Journal of managing projects in business*, 230-247.

Briggs, R. (2015). *Normative Theories of Rational choice: Expected Utility.* Stanford: http://plato.stanford.edu/archives/win2015/entries/rationality-normative-utility/.

Bryngelsson, L., & Mannerstål, C. B. (2015). *Gap-analys av PEABS riskhantering mot ISO 31000 (Riskhantering - Principer och riktlinjer).* Canea Consulting Group.

Cohen, D., & Crabtree, B. (2006, July). *Qualitative Research Guidelines Project*. Retrieved February 2016, from Qualres: http://www.qualres.org/index.html

Edwards, P., & Bowen, P. (1998). Risk and risk management in construction; a review and future directions for research. *Enginering, Construction and Architectural Management*, 339-349.

Epley, N., & Gilovich, T. (2006). The Anchoring-and-Adjustment Heuristic. *Psychological Science*, 311-318.

Eweje, J., Turner, R., & Muller, R. (2012). Maximizing stratetig value from megaprojects: The influence of information-feed on decision-making by the project manager. *International journal of project management*, 639-651.

Fahey, L., & Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California management review*, 265-276.

Fisk, E. R. (2003). *Construction Project Administration.* New Jersey: Prentice Hall Upper Saddle River.

Garicano, l. (2000). Hierarchies and the organization of knowledge in production. *Journal of political economy*, 874-904.

Håkansson, M. (2011). *Riskhantering i processen Investera och reinvestera transportsystemet.* Trafikverket.

ISO. (2016). *ISO*. Retrieved from ISO.org: http://www.iso.org/iso/home/standards/iso31000.htm

ISO Technical Management Board Working Group. (2009). *ISO 31000.* ISO Technical Management Board Working Group.

KarimAzari, A., Mousavi, N., Mousavi, S. F., & Hosseini, S. (2011, August). Risk assessment model selection in construction industry. *Exper Systems with Application*, pp. 9105-9111.

Kartam, N. A., & Kartam, S. A. (1999). Risk and its management in the Kuwait constrution industry: a contractors perspetive. *International Journal of project management*, 325-335.

Lam, K., Wang, D., Lee, P. T., & Y.T., T. (2007). Modelling risk allocation decision in construction contracts. *International journal of project management*, 485-493.

Maqsood, T., Finegan, A. D., & Walker, D. H. (2010). Biased Heuristics in Judgement and Decision Making: The Dark Side of Tacit Knowledge. *Informing Science and Information Technology*, 296-301.

mcgregor. (2016, February 16). *Online course.* Retrieved from Sportrisk: http://www.sportrisk.com/online-course/

Mills, A. (2001). *A systematic approach to risk management for construction.* Melbourne: Emerald Insight.

Noor, K. (2008). *Case Study: A Strategic Research Methodology. American Journal of Applied Sciences. Science Publications 1602. Vol. 5, No. 11, pp. 1602-1604.* Shah Alam: Science publications.

Peab. (2007). *Sammanfattning för Arbetsmiljöverkets inspektörer*. Peab.

Serpella, A. F., Ferrada, X., Howard, R., & Rubio, L. (2014). Risk Management in Construction Project: A Knowledge-based Approach. *Procedia- Social and Behavioral Sciences*, 653-662.

Walke, R. C., & Topkar, P. D. (2012). Risk Quantification Model for Construction Projects using Score Model and EV analysis approach. *International Journal of Engineering Research and Applications*, 2312-2317.

Wikipedia. (2016, Januari 24). *Lerum kommun*. Retrieved from Wikipedia: https://sv.wikipedia.org/wiki/Lerums_kommun

Wikipedia. (2016, January 16). *Trafikverket*. Retrieved from Wikipedia: https://sv.wikipedia.org/wiki/Trafikverket_(Sverige)

Winch, G. M., & Maytorena, E. (2009). *Making good sense: Assessing the quality of risky decision-making.* London, New Delhi and Singapore: SAGE Publications.

Yates, J. F. (1992). *Risk-taking behavior.* Chichester: John Wiley and sons Ltd.

Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2010). Risk management of construction projects. *Journal of Civil Engineering and Management*, 33-46.

Zhao, Z.-Y., & Duan, L.-L. (2008). *An Integrated Risk Management Model for Construction Projects.* Beijing: North China Electric Power University.

Zhi, H. (1995). Risk management for overseas construction projects. *International Journal of project management*, 231-237.

Appendix 1

Research questions formulated into two semi-structured interviews that were conducted on selected clients and staff members of the case study company as shown below:

The interview was conducted to find out how the risk management process is perceived and worked with throughout the hierarchic levels in the organization. If there is anything special that the respondents wants to add regarding the subject and to find out how different decisions is carried out in the organization.
Interview questions:

1. Vad har du för position inom i företaget?
    a. Vad innefattar den?

2. Hur arbetar du med risker i vardagen?
    a. Skulle du påstå att riskhantering spelar en stor roll i ditt arbete och i så fall hur?

3. Finns det någon kommunikation angående risker mellan olika nivåer i företaget?
    a. Hur sker detta i så fall?
    b. Är det någon speciell risker som ”förflyttas” mellan nivåer i organisationen? Exempel på detta
    c. Vem utses till riskägare?
    d. Vem utför dokumentationen?
    e. Vem sköter uppföljningen?
    f. Vad anser du om de tillgängliga verktygen?
4. När du arbetar med risker följer du någon specifik formalia eller bygger du dina beslut mestadels på erfarenhet?
    a. Vilken faktor påverkar mest hur du hanterar en risk?
        i. Kundens krav
        ii. Egen erfarenhet
        iii. Övriga aktörer
        iv. Verksamhetsledningssystemet
    b. Används något annat dokument?
    c. Dokumenteras riskhanteringen?
5. Hur fungerar riskhanteringen i verksamheten/projektet?
    a. Vem utför riskidentifieringen/analys/utvärdering?
    b. Hur ofta utförs/uppdateras a.?
    c. Vem är ansvarig för riskbehandlingen (åtgärder)?

6. Känner du till företagets riskhanteringsprocess?
    a. Beskriv processen på den nivån du verkar
    b. (Känner du till något överhuvudtaget)

7. Finns det någon som kontrollerar/följer upp att riskhanteringen görs på rätt sätt?
    a. I så fall vem?

8. Från din position, vilka risker är mest frekvent förekommande?

a. *Om det är någon risk som inte nämns*, vad anser personen om dessa?

9. Vilka risker ingår i riskidentifieringen för verksamheten/projektet?

10. Upplevs det som det finns något specifikt problem angående riskhanteringen i allmänhet?

11. Värderingen av risker som påverkar tid och kostnad
    a. Reflekteras det över dessa värderingar?
    b. Vad får detta för konsekvenser?
    c. Förekommer det någon återkoppling, i så fall för att inte utsättas för denna risk på kommande verksamhetsår/projekt?

12. Hur hanteras risker i extrema tillfälle? (*Extrem storm, risk för dödsfall (spontfall, krankollaps), låg sannolikhet men hög konsekvens.)*
    a. Skulle risken då kanaliseras till en högre nivå i organisationen?

13. Hur skulle du ranka riskerna?
    a. Projektspecifikt
    b. För företaget
    c. För dig personligen

Appendix 2

Result from the survey with all the different risks asked to be valuated from three different perspectives.

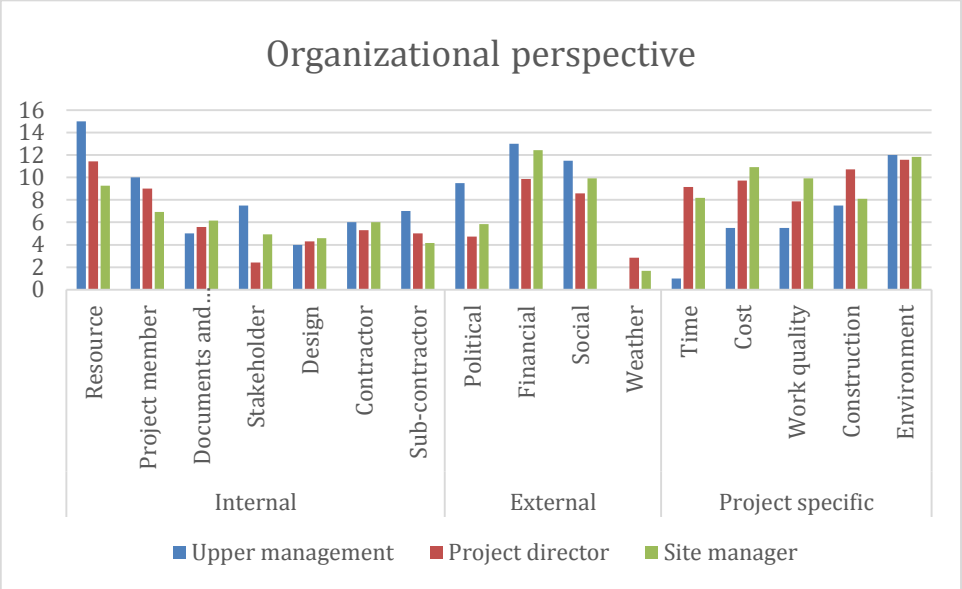

Figure 10 - Valuation of all the risks with regards on the organizational perspective

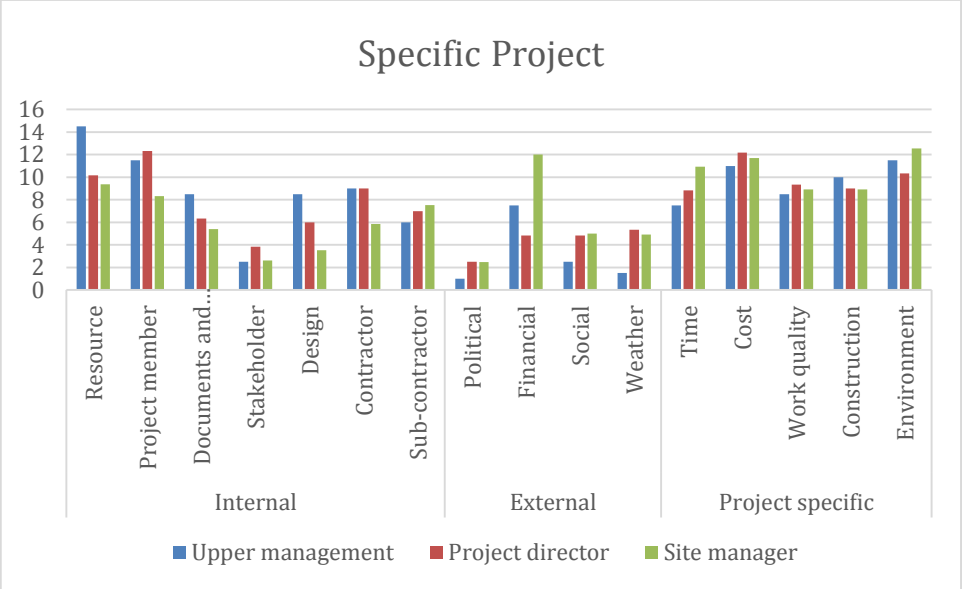

Figure 11 - Valuation of all the risks with regards on the specific project perspective

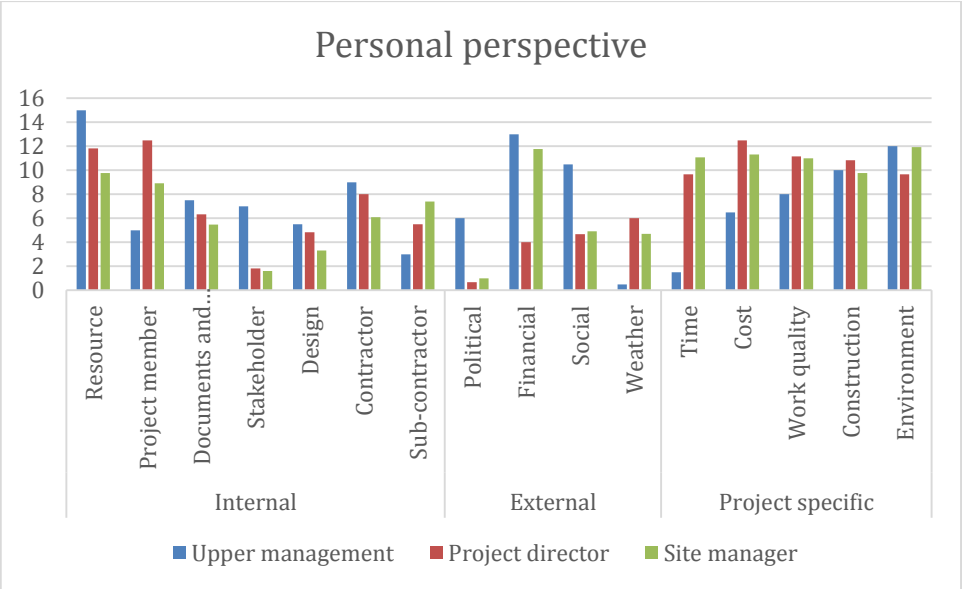

Figure 12 - Valuation of all the risks with regards on the personal perspective