CHALMERS
UNIVERSITY OF TECHNOLOGY

Project risk management in the construction industry: comparing theory and practice

Master's Thesis in the Master's Programme Design and Construction Project Management

SEBASTIAN ANTONSSON
BOKI VOJVODIĆ

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2017
E2017:082

MASTER'S THESIS **FEL! HITTAR INTE REFERENSKÄLLA.**

Project risk management in the construction industry: comparing theory and practice

Master's Thesis in the Master's Programme Design and Construction Project Management

SEBASTIAN ANTONSSON
BOKI VOJVODIĆ

Division of Service Management and Logistics
Division of Service Management and Logistics
GOTHENBURG, SWEDEN 2017

Göteborg, Sweden 2017

Project risk management in the construction industry: comparing theory and practice

Master's Thesis in the Master's Programme Design and Construction Project Management

SEBASTIAN ANTONSSON
BOKI VOJVODIĆ

Examensarbete **Fel! Hittar inte referenskälla.**
Chalmers tekniska högskola 2017

Division of Service Management and Logistics
Division of Service Management and Logistics
Gothenburg, Sweden 2017
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
Illustration made in Photoshop by Sebastian Antonsson and Boki Vojvodić.
Chalmers repro Göteborg, Sweden, 2017

Project risk management in the construction industry: comparing theory and practice

Master's thesis in the Master's Programme Design and Construction Project Management

SEBASTIAN ANTONSSON
BOKI VOJVODIĆ
Division of Service Management and Logistics
Division of Service Management and Logistics
Gothenburg, Sweden 2017

ABSTRACT

This study will investigate the construction industry's project risk management processes in order to conduct a comparison between their process in practice and processes described in literature. Furthermore, tools and techniques, also found in literature, will be used in the comparison.

To conduct this comparison, a frame of reference was made. This frame of reference contains methodologies, standards, handbooks, tools and techniques that are commonly found associated with project risk management. Amongst the methodologies, the most common one is the PMBOK. In the tools and techniques chapter, the SWOT, Monte Carlo simulations and Risk matrices are some of the more common ones.

14 interviews at 11 companies were conducted for data collection. The data showed that the industry's application of risk management is very similar amongst all companies. The processes were often not as structured and developed as the literature suggests and most tools and techniques were not even used. The most common way to do risk management was to conduct workshops where the risks were identified with help from experts.

Further, the analysis showed that none of the methodologies from the literature were followed. Parts of it were used but the usage was never associated with any specific methodology. When it comes to the tools and techniques, a few were used quite frequently and some were used but less frequently. Risk matrices were very common and so was Brainstorming as well as Checklists. SWOT and Monte Carlo simulations were used sometimes though not very often.

The research showed that the industry is very keen to maintain a simple and easily understandable process. Complex tools such as simulations and advanced systems of qualitative analysis such as Delphi, were not used very much at all. Another common aspect was the lack of clear structure and standardization in the process. Few companies had a standardized process which could be applied in projects. Knowledge transfer was another area where improvement was needed.

Key words: Construction, Management, Project, Risk, PMBOK

Projektriskhantering i byggindustrin: jämförelse mellan teori och praktik

Examensarbete inom masterprogrammet Design and Construction Project Management

SEBASTIAN ANTONSSON
BOKI VOJVODIĆ
Institutionen Teknikens Ekonomi och Organisation
CHALMERS TEKNISKA HÖGSKOLA

SAMMANFATTNING

Denna studie undersöker byggindustrins riskhanteringsprocesser i projekt för att jämföra hur de används i industrin, mot hur de teoretiskt beskrivs i litteraturen. Processer tillsammans med olika verktyg och tekniker inom projektriskhantering kommer också att användas i jämförelsen.

Ett teoretiskt ramverk har sammanställts i studien för att göra jämförelsen möjlig. Ramverket innehåller olika standarder, metodologier, tekniker och verktyg som kan användas i byggindustrins riskhanteringsprocess. Den mest kända metodologin var den som beskrevs i PMBOK® vilket många författare baserade sina handböcker/standarder på. Bland teknikerna och verktygen uppmärksammas bland annat SWOT, Monte Carlo samt Riskmatriser som de mest vanliga.

Den empiriska delen bestod av intervjuer riktad till personal på företag som arbetar med projektriskhantering eller med kunskap inom området. Resultatet från intervjuerna visade att riskhanteringsprocessen var väldigt homogen bland de flesta av företagen. Vanligt förekommande var att tillvägagångssättet för riskhantering inte var standardiserat, de flesta verktyg och tekniker från litteraturen användes inte alls. Vanligast var att ha workshops där intressenter för projekten deltog för att se till alla möjliga risker tas upp. Sen var också riskmatriser vanligt förekommande.

Analysen visade att inga av metodologierna användes helt och hållet, enbart delar ur dem hade anpassats efter företagens egna krav som de sedan nyttjade efter behov. Riskmatriser, Brainstorming och Checklistor var vanligt förekommande. SWOT och Monte Carlo simuleringar användes i ett fåtal fall.

Studien visade att industrin är väldigt mån om att behålla ett enkelt tillvägagångssätt. Avancerade verktyg som t.ex. Delphi och diverse simuleringar undveks. En vanlig orsak till detta var att processen inte var tydligt formulerad, strukturerad, eller inte var överskådlig. En annan aspekt som behövde förbättras var kunskapsöverföringen mellan projekt och anställda.

Nyckelord: Byggindustrin, Konstruktion, Riskhantering, Projekt, Styrning, Risk

Contents

Figures

Tables

Definitions and word list

Risk:
"Risk" can be seen as an uncertainty that if it occurs, has an impact on project objectives. This is true in itself but does not entirely describe what the nature of this "uncertainty" might be, and this is often not highlighted in the more common versions of the definition of risk (Bissonette, 2016). It is often trivial to think that using the word "risk" implies that only something negative can happen. PMBOK® (2013) has used their definition with the distinction that risk can both be negative as well as positive (opportunity). In this paper, a risk will be defined as "an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project's objectives" (PMI, 2013, p. 309).

Cause and effect:
"Cause" and "effect" are two other words which could be used in direct relation to the word "risk" (Bissonette, 2016). An important divergence exists between "risk" and "cause" in which "cause" is a fact or a condition and "risk" is (as mentioned above) an uncertainty that has an impact on the project. In order to avoid misinterpretations, Bissonette (2016) suggest an implementation of a "risk metalanguage" and the use of a generic sentence:
"As a result of <CAUSE>, <RISK> may occur, which will lead to <EFFECT>"
When filled in, this sentence will already have mentioned three identified elements of risk.

Uncertainty:
"Uncertainty" is hard to distinct from "risk" and is often thoughtlessly used as the same thing. The PMI (2013) puts an emphasis on that risk is something different from uncertainty where uncertainty could be described as a condition in which the future outcome is not sure. It can also be seen as something that has a probability of happening. Risk uses uncertainty in its definition, but they are not the same things (Rachev et al. 2011). Where there is uncertainty, risk may occur (see above definition of risk).

Probability:
In project risk management, probability is used to determine the likelihood of a certain risk to happen. The most common way to show the probability is through either a number 0-1 or a percentage. However qualitative risk management often use a relative scale ranging from low-high or similar. The scale can differ and include several levels of impact.

Preface

This study was made as the thesis for the master's program Design Construction Project Management written in the Department of Technology Management and Economics. The study was conducted in Gothenburg, Sweden, with an aim on the construction industry and how they manage risks in their processes. The theoretical part was formed by handbooks, standards and methodologies found by the authors during their research on the subject of Project risk management. The empirical data was formed from interviews conducted together with the authors and employees from around Sweden which has some kind of relation with risk management in their company.

The results were surprising, showing that not much from the books are implemented in practice. This pattern was shown in the majority of the interviews with only a difference showing between the contractors and the consultants. This shows that there is still a wide gap between the academic world and the construction industry.

The thesis could not have been made without the help of interviewees, thank you for taking your time to answer our questions for the study. Furthermore we want to thank Chalmers University of Technology for giving us the opportunity to write the thesis and supplying us with information from their services. Last but not least we want to thank our examiner and supervisor, Pernilla Gluch for her guidance and expertise in the academia.

Göteborg June 2017

Sebastian Antonsson and Boki Vojvodić

1 Introduction

This chapter introduces the aspect and theme for the study. It covers the background for the study, its purpose and objective, as well as the limitations and the research questions. The chapter also includes a definition and word list part where some central terms are being described in the subject of Project Risk Management.

1.1 Background

According to Brunes & Lind (2014) 86% of 250 large infrastructure projects had cost overruns averaging at 28%. Some reasons mentioned include geotechnical difficulties, lack of competence from consultants and project managers, poor documentation, poor project management, do not consider price increases, wrong budgeting and communication problems, to mention a few. While some of these are hard to fix with risk management, many of them can be. Price increases for example can be dealt with proper risk management by identifying responses should the increase happen. Wrong budgeting can be helped by using Monte Carlo simulations to generate a precise probability curve which enables better identification of correct project costs and budgeting. Same goes with the lack of competence from consultants and project managers, conducting proper risk management one could identify the risk in certain consultants, such as inexperience. Many of the common reasons for project failure can be removed or at least have their impact reduced by proper risk management.

Due to increased competition in the construction industry, companies are forced to take on projects with smaller margins in the budget thereby taking more risks (Bissonette, 2016). According to several project management guides such as the PMBOK®, risk management is an important part of project management. The reason for most project failures is due to poor management of risk (Hubbard, 2009). This naturally puts emphasis on the risk management as a way to reach project success. In the construction industry failures to reach project success are common, risk management might play a crucial part in identifying and managing risk that might lead to project budget and time schedule overruns.

The construction industry is a project based industry, which means each project is fully or partly unique. The complexity of construction projects coupled with its unique properties, creates a potential for new and unknown risks and opportunities. Harnessing the industry's potential and managing the threats can be of great value to its project and the organizations within the industry.

The literature about risk management is in abundance. Every project management guide contains a risk management chapter. However, few of them are adapted directly to the construction industry, they serve more as a general guide for project risk management. Thus, it is highly useful to scrutinize the literature in order to extract useful information that is useable in a construction project.

A common misconception is that risk management only has to do with financial risks. Another one, specifically in the construction industry, is that risk management is only related to work environment, such as a wall collapsing on a construction worker.

1.1.1 Purpose

The purpose of this thesis is to identify contemporary project risk management procedures and compare them to the literature available on the subject. After the comparison, improvements will be suggested to overall project risk management as well as a contribution to the body of knowledge.

1.1.2 Objectives

- Establish a frame of reference based on current theory and literature about project risk management.
- Gain knowledge about the process of project risk management in the construction industry.
- Analyze and discuss the difference between the theory on risk management and the practice as described by industry representatives.

1.1.3 Limitations

The thesis will provide a review on project risk management on a general level while the comparison will focus on the construction industry. The thesis will focus only on risks at project level. Higher impact risk such as strategic risks, organizational risks and financial risks will not be considered. Risks that are connected to work environment, workers' health and safety will not be covered. The thesis will be limited to the Swedish construction, infrastructure and consultancy industries.

1.1.4 Research questions

- How do companies perform risk management on construction projects?
    - What tools and techniques are used?
    - Do companies use a certain standardized process for risk management?
- Can the processes used by companies be improved with support from literature?
- What can be added to the literature in order to provide a more complete picture of project risk management?

2 Method

The research followed a deductive pattern, starting off by assembling the theory into a frame of reference then using that to analyze the real world. The goal after comparing reality with theory is to either, get a confirmation of the theoretical applications or find additional information from the real world to complete the theory (Bryman & Bell, 2015).

2.1 Interview study

The interviews were semi-structured, a handful of wide questions that would allow the interview to answer freely. After a few open questions, number questions regarding the use of tools, methods and techniques were asked. The interviewers used a notepad to take notes during the interview as well as recording the interview using a phone.

The interviews were semi structured in order to allow the interviewee to freely discuss the topic alongside our questions. In order for the study to be more complete it required more than just theory including frameworks and tools. The study aimed to make a comparison between the risk management methodologies and tools used in the construction industry, and in order to the make the comparison, information had to be found about the industry, preferably in an up-to-date format. An increase in both reliability and validity were of importance and puts emphasis on the interviewing approach as well as the selection of interviewees (Andersson, 1985).

2.1.1 The selected subjects

The thesis focus on risk management in projects, therefore the interviewees chosen should be working in this area, as well as being involved in the construction industry. Project managers and their superiors were suitable subjects, due to the project managers' involvement in risk management processes, and their superiors which might have a different experience and view of the field. The aim was to extract from the subjects how they are working with project risk management in the construction industry today. To get a better understanding of how the work was performed, an identification of the different methodologies and tools used had to be done.

The subjects were picked based on their relevance (e.g. project managers in the construction industry) and were contacted mainly via e-mail and in some cases by phone. A connection had to be established in which subjects chosen were asked to be part of interviews where questions revolving project risk management would be the main focus. Subjects which agreed could not always attend the interviews in person, therefore teleconferences (using Skype) were held with the intention to keep the interviews on a more personal basis. A preference for meetings of the virtual kind is to try to make them into some kind of face-to-face session, mostly for the communication to get more dimensions but also to eliminate parts of the hierarchical phenomenon (Rhoads, 2010).

The subjects came from a total of 11 companies, all having a focus on the construction industry. Focus was on larger companies because of the expectation that they had more sophisticated risk management procedures and would provide better results.

The interviewees are anonymous with only their relevant title being exposed to the thesis, they are as followed:

Table 1: List of interviewees with their titles.

	Interviewees	Duration (min)	Medium
1	Sustainability strategist	30	In person
2	Project manager	55	In person
3	CEO of consulting company	55	In person
4	Project manager	50	In person
5	Risk manager	45	In person
6	Head of department Construction projects	40	In person
7	Environmental and quality coordinator	35	In person
8	Risk manager	75	Phone
9	Project manager	50	Skype
10	Head of division facilities	60	In person
11	Head of department business development	45	Phone
12	Head of department construction	65	In person
13	Manager	50	In person
14	Risk analyst	60	In person
15	CEO of consulting company	70	In person

2.2 Literature study

At the start of the study, a literature review was conducted. The literature review was done with the purpose of gathering information about risk management in order to construct a frame of reference upon which the study rests. The frame of reference of the thesis has been assembled by gathering information from the internet. The bulk of the content comes from scientific articles and methodology handbooks about project risk management, project management, risk management and other subjects connected. The literature was retrieved mainly from Chalmers online library and Google Scholar.

The focus was on well-known handbooks containing processes, tools and techniques. However, it was somewhat hard to grasp the extent of how well known some were, a few references are included that might not be entirely well known. Due to the abundance of handbooks describing risk management they had to follow certain criteria. First, they must cover the subject of Project risk management. Second, they should contain a systematic process which could be practically implemented. Third, the list of handbooks and guides could be too long to manage so a limitation of 5 handbooks and guides was enough for the comparison.

When it comes to the tools and techniques, the chosen ones were all extracted from the handbooks and guides. The tools and techniques mentioned most often were started with and then the study moved on further into less known tools and techniques. Most common ones were *SWOT*, *Checklists*, *Brainstorming* and *Risk matrices*. Others such as *Delphi*, *Risk breakdown structure* and *Fault-tree-analysis* were studied following the initial ones.

In all these it was important that some examples of its application in the construction industry were found. For that reason, a certain amount of time and effort was spent on researching these methodologies, tools and techniques to find examples of them being used. The main purpose of this was to ensure these had been used in construction and therefore were valid for this study.

2.3 Reflection of study

As the range of interviewees was rather limited, 14 interviews, it could be argued that it is not enough data to draw solid conclusions. Also, two of the interviews were considered less valuable to this study due to their focus on organizational risk management rather than project risk management. However, considering that the answers were quite similar from nearly all the interviewees, the results can probably be trusted. Another aspect that could have been done better is to have included a wider spectrum of professional roles in the interview study. The interviews were mainly conducted with project managers and higher managers but not one single site manager. However, many of the interviewees had previous experience from working on site, so this may not be an issue. It would have been interesting to interview some smaller companies to see the difference in their way of working as opposed to the rest.

The choice of doing interviews and not a survey was because it was seen as beneficial to have face to face meetings. This enables the interviewees to discuss more openly but it also gave the interviewers a chance to explain certain terminology better. However, a survey might have reached out to a larger part of the industry, providing a statistical foundation of data.

3 Frame of Reference

This chapter contains the theoretical background for the thesis from various sources with a majority derived from literature in the form of scientific reports as well as handbooks describing different methods and tools which can be used in project risk management. The chapter is structured beginning with the literature defined as the collection of handbooks and standards associated with project risk management. The next part will describe some common techniques and tools used in project risk management. In the end, the application in the construction industry of the tools, techniques and methodologies are presented.

3.1 Literature

This subchapter contains the studied literature in the form of handbooks and standards. They are sorted alphabetically and not in any order which denotes their relevance or scientific value.

3.1.1 PMBOK®

The PMBOK® was written and published by the Project Management Institute (PMI). The 5th edition, released in 2013, was reviewed.

According to the PMBOK®, risk management should be a process that follows the project from planning stage to the end and should be updated as necessary. Before embarking on the risk management journey certain terms should be decided upon. Terms such as the level of uncertainty the stakeholder are willing to accept, how big risks are accepted and how big potential impacts are accepted.

The PMBOK® defines risk as an event that affects the project objectives, in case it occurs. Risks are directly connected to the uncertainty inherently associated with projects. The risk can have a positive effect on the project but it is still defined as a risk. Risks can be known, and therefore analyzed and proactively managed. They can also be unknown, in that case where they cannot be analyzed and planned for instead there should be a monetary reserve ready to deal with these risks.

The PMBOK® identifies six main steps in dealing with project risk.

- Plan risk management
- Identify risks
- Perform qualitative risk analysis
- Perform quantitative risk analysis
- Plan risk responses
- Control risks

1. Plan risk management

The Risk Management Plan (RMP) is the plan for how the risk management will be conducted. This plan is used as a base for future risk management and is also important in communicating the plan to other stakeholders. The plan is based on other project

management documentation such as the project charter and the project management plan but should also take into consideration the stakeholders involved.

This phase should produce a plan that includes and describes the tools and methods that are going to be used, times and budgets associated with the project, a definition of the probability and impact of the risks and other documentation describing in detail how the risk management will work, such as reporting and documenting.

2. Identify risks

Risk identification is a vital part of risk management. Here risks are identified through various methods such as meetings, brainstorming and scrutinizing project documents. The risks are then assembled into a register which is later used for risk response planning.

3. Qualitative risk analysis

The risks are analyzed and ranked according to their impact level and probability. The qualitative analysis gives a strong understanding of which risks are most important to focus on. After doing the qualitative analysis, a probability and impact matrix should be produced in order to have a clear picture of the risks and their importance. This is usually done by conducting workshops or interviews so that expert opinions can be gathered. (PMI, 2013).

4. Quantitative risk analysis

The quantitative analysis builds on the qualitative in that it goes further in the analysis of the most important risks. In the quantitative analysis, the risks are analyzed using various tools such as probability distribution, sensitivity analysis and expected monetary value analysis. The key here is to see the impact the risks have, often in monetary values, but also their probability of occurring.

5. Plan risk response

After the quantitative analysis is done, a plan on how to deal with the risks should be set up. There are four basic ways of dealing with risk:

- ***Avoid*** - This response means that the risks are actively removed by taking measures to ensure the risks will not occur or have no impact.
- ***Transfer*** - This response means that the risk is transferred to another stakeholder, such as a subcontractor or client. This is often done on contract level by shifting responsibilities.
- ***Mitigate*** - Mitigating a risk means reducing the impact of the risk and or probability of a risk. For example by making less risky choices or by preparing contingency plans.
- ***Accept*** - Accepting a risk means to accept the risk and its impact by not actively managing it.

However, these responses are only valid for negative risk. Positive risk can be dealt with in a different manner.

- ***Exploit*** - Exploiting a risk means to ensure that a risk that has a positive outcome will occur.
- ***Enhance*** - Enhancing the risk means to actively work on increasing the risk probability and or impact.
- ***Share*** - Sharing the risk means to share the positive effects of a risk with other stakeholders.
- ***Accept*** - Accepting a positive risk means no active measures are taken to ensure its occurrence.

6. Control risks

The control includes implementing risk responses, monitoring the project and updating the plans if necessary. The key aspect here is to be ready to treat risks that have already been identified but also to identify new risks.

3.1.2 ISO 31000:2009

The ISO 31000:2009 is a collection of standard related to risk management made by the International Organization for Standardization. The reviewed edition is the first and was made in 2009.

The ISO 31000:2009 is the international standard for risk management. It is a standard meant to provide guideline rather than a standardized way of work depending on the organization implementing it (ISO 31000, 2009). The ISO standard recommends organizations to develop their own risk management framework to be constantly developed and integrated into their work processes. This is due the knowledge that there is no real standard approach to all types of risks, therefore a framework must be developed and adapted to the organization which will use it. The ISO 31000:2009 standard states that in order to successfully develop a risk management framework the following must be taken into consideration: "the varying needs of a specific organization, its particular objectives, context, structure, operations, processes, functions, projects, products, services, or assets and specific practices employed" (ISO, 2009, p.4).

3.1.3 AMA Handbook of Project Management

The AMA Handbook of Project Management was written by Paul Dinsmore and Jeanette Cabanis-Brewin and published by AMACOM. The edition reviewed is the 4th released in 2014.

The AMA handbook of Project Management also follows a similar structure as the PMBOK® and all the same elements are included. The AMA divides the risk management into two groups, implicit risk management which deals with overall project risk and explicit risk management which deals with individual risks on project level. In similarity to the PMBOK®, the AMA also puts some weight on setting certain

limitations, threshold for risk acceptance, how much risk are the stakeholders willing to accept, deciding on how to assess the qualitative analysis and defining sources of risk.

However, the AMA puts more emphasis on detailing the risks that have the potential of occurring. The risks can be categorized in four categories:

1. **Technical risk-** These risks are part of the technology involved in the project. For example, the requirements of a technological aspect can change, technology can be hard to scale and the performance of the technology.
2. **Management risk-** Management risks involve the project management team. This could mean poor management, poor communications and poor work environment.
3. **Commercial risk**- Commercial risk involves risks within the contractors and agreements, procurement risks and financial risks.
4. **External risk**- External risks are risks that exists beyond the project. This includes legislation risks, currency rates, political instability and natural phenomena.

The AMA also states that in risk identification, it is important to separate risks, causes and effects from one another, they are not each other's equivalent. A risk is an uncertainty, have a probability of occurring and an impact on the project. A cause is the reason for why the risk exists and the effect is the impact itself from a risk that has occurred.

3.1.4 GOWER Handbook of Project Management

The GOWER Handbook of Project Management is written by Rodney Turner and published by GOWER. The reviewed edition is the 5th which was released in 2016 was released.

The GOWER Handbook of Project Management provides a step by step process in dealing with project risk. It is heavily influenced by the PMBOK® but provides its own approach. GOWER also puts emphasis on the fact that simply following a step by step method will not ensure safety of the project. Other factors such as the people in the project and the organization are important factors to include. The GOWER handbook also emphasizes the fact that risk come from all sources of uncertainty not only events. Which accordingly to the author is something many project managers miss to take into consideration.

The 8-step process provided by the handbook is as follows:

Table 2: 8-step process for Project management (Turner, 2016).

Step		Description
1	Initiation:	What is the goal? Defining scope and objectives.
2	Identification:	Which are the potential risks?
3	Qualitative assessment:	Identifying the most important risks.
	Quantitative analysis:	Assessing the impact and probability of the risks.
4	Risk response:	Plan how to deal with identified risks.
5	Implementation:	How do we implement the responses?
6	Communication:	Informing those who need to know about the risks and their management.
7	Review:	Identify new risks, update about changes and new responses.
8	Post-project review:	What did we learn?

The handbook states that current risk management often fails due to lack of clear guidance in responding to risks. This leads to a lot of analysis and documentation of risks and responses but fails to implement it. The handbook also states the importance of learning from projects in order to improve. Which is something entirely omitted by the PMBOK® and the AMA. It is also mentioned that the responses suggested, avoid, accept, mitigate and transfer, can have considerable impact on the overall project. An example mentioned in the handbook is that attempting to avoid a risk might lead to cancellation of the project. These high-level effects of certain actions must be considered when choosing how to respond to risks. It is also highly important to define the response clearly and thoroughly as well as monitor them after they have been implemented in order to see if new risks appear or if the sought-after effect was achieved.

The handbook also mentions the importance in properly communicating results, conclusions and recommendations to other stakeholders. The people involved have a big impact and it is very evident when risks are being assessed. People see risks in different ways and what some might see as a high risk others might not see as a risk at all. Four types of attitudes towards risk are identified:

1. *Risk averse*: Those who see risk as something entirely negative and should be avoided or minimized at all costs.
2. *Risk seeking*: Those who see risk as a potential for profit.
3. *Risk tolerant*: Those who see risk as both something negative but also something that might positive.
4. *Risk neutral*: Those who don't really care about the risks but prefer to think innovatively and big.

In order to tackle complex projects, Turner (2016) offers four approaches to deal with the complexity of such projects. *Internal and content approach*, *systems management with focus on control*, *interactive management with focus on interaction* and *dynamic management with a balanced focus*. The first one, *internal and content focused approach*, is the approach of not following any structure and thus should be avoided. The second one is the classic project management methodology as described by the Project Management Institute (2013). Here it is suggested to ensure a strong focus on transparency and documentation to delegate responsibility and manage changes. The third approach focuses on dealing with changes which is an important aspect of dealing with risk. Changes in the project present new risks and uncertainties and can themselves be a risk that occurred. Following the interactive approach the capability to handle the changes should be available and ready but in this case not necessarily planned for, as this approach focuses on the do part rather than the plan.

The final approach and the best choice according to Turner (2016), is the dynamic approach. The dynamic approach is the approach of planning and following a structured form such as the one presented by the PMI (2013) but also allowing the interactivity and flexibility needed to respond to changes.

3.1.5 Practical Project Risk Management: The ATOM Methodology

The Handbook was written by David Hillson and Peter Simon and was published by management Concepts. The edition reviewed is the 1st and was released in 2007.

The book describes a project risk management methodology abbreviated as ATOM, standing for Active Threat and Opportunity Management. The methodology defines a standardized process in managing project risk. The definitions of risk are adopted from the PMBOK®. However, the ATOM process is often entirely qualitative in contrast to PMBOK®, AMA and GOWER which all use some quantitative analysis. ATOM suggest using quantitative analysis only in large projects. The ATOM method is adaptable to all sizes of a project due to its scalability.

3.1.6.1 Active Threat and Opportunity Management - The ATOM Risk Process

The process that Hillson & Simon call ATOM, is based on a similar base as the PMBOK® and AMA. The steps included are identifying risks, assessing risks, planning risk treatment, reporting, implementing and reviewing. This process, akin to the GOWER handbook, includes a review, or learning, step. This step is important for future projects is that the same mistakes are not repeated. The first step is initiation.

Being able to correctly scale a process, as mentioned earlier in success factors, also puts some importance on properly sizing the project. This step should produce the risk management plan.

After the initiation the risk identification, assessment and response planning is done. These steps are very similar to the other methodologies such as the PMBOK®. Reporting and reviewing risk continuously throughout the project is important in order to identify new risks, ensure the risk responses are working as intended and updating necessary project documents. At the end of a projects, a project level review should be done in order to help future risk management.

3.1.6.2 Success factors

Hillson & Simon (2007) identifies four factors that are vital for the risk management to be successful. These are a supportive organization, competent people, an appropriate supporting infrastructure and a good process.

A supportive organization means that the people involved, at all levels, support and engage in the process. In similarity to previously mentioned methodologies, people can have different attitudes towards risk management and thus behave differently. The attitude has a major impact on how supportive they are and how willing they are to cooperate. For instance, some people that are very risk averse, might deny the existence of risks by claiming to be experts. Others might be very risk seeking and thus put the entire project in danger due to taking extreme risks.

The second important factor is ensuring that the people in the project are competent. This means that they should be aware of what risk management is, how it works and how it affects them. Training might be necessary in order to spread the awareness to everyone in the organization.

Having a solid infrastructure is important as it ensures the organization has the proper tools necessary to manage risks that are relevant to them. This also helps with training the people in understanding the tools and methodologies and thus using them properly. It also helps the organization in purchasing viable tools, both from a cost perspective but also from a competence perspective.

The last part is about ensuring the process that is set can be scaled to all projects and risks within the organization. This can mean having a very strict and detailed process but it can also mean having a more dynamic process that can be adapted to different types of projects and risks.

3.1.6 A Practical Implementation Approach

The book, A practical Implementation Approach, was written by Mike Bissonette and was published by the Project Management Institute (PMI) in 2016.

The author of the book gives a holistic approach to project risk management. It focuses on project-based work, therefore financial risk etc. are not included but just mentioned

in the methodologies. The purpose of the book is that it is supposed to be of practical use for project managers and is therefore more straightforward but enough in-detail to explore the risk management process as a whole (Bissonette, 2016).

Project management has developed a lot over time and has provided the organizations and industries with competencies, tools, and techniques to optimize their project results, therefore one of the book's focuses is to strive after best practice methods. Bissonette (2016) uses the PMBOK®'s six main steps in dealing with project risk as a starting point as well as describing the principles and methods used in them. Furthermore, the comparable parts in the tools and methods, in which different theories are presented, are explored as well as the general view of the project risk management aspects.

The definition of risk is presented and also the distinctions between risk, cause and effect putting emphasis on the importance of understanding these certain words. A risk is either a threat or an opportunity, and a common tool to analyze businesses, projects and people is the SWOT tool (strengths, weaknesses, opportunities, and threats) which clearly draws this distinction. The problem is that organizations and industries has not yet accepted these distinctions as working standards and may cause unneeded confusion (Bissonette, 2016).

According to Bissonette (2016) projects which aims for success in project executions should have an RMP, but this type of document might not be necessary if the projects are relatively small and low risk. Even so, it is still considered good practice and could be used as a framework. The content of an RMP may vary, and an example for what it might contain was presented by Bissonette (2016) as followed:

1. General Information
2. Methodology
3. Roles & Responsibilities
4. Risk Management Budgeting
5. Risk Management Scheduling & Timing
6. Project Risk Categories
7. Individual (Qualitative) Risk Assessment Definitions
8. Project Stakeholder Tolerances
9. Risk Reporting Formats
10. Initial Risk Assessment – Assumptions & Risks
11. Monitoring & Controlling Project Risks

A list of practical methods for identifying project risks were presented and of these a combination of *Brainstorming*, *Interviewing*, and *Expert judgement* (not necessarily in that order) is probably the most common approach according to Bissonette (2016). Expert judgement refers to people in possession of accumulated knowledge about risks. These experts are either working internally in the organization but can also be consultants from external organizations such as subcontractors. The experts use sessions where they are brainstorming together with stakeholders as well as interviewing subject with more knowledge of the risks at hand. These methods

(*Brainstorming*, *Interviewing*, and *Expert judgement)* are all relying on methods which are not thorough enough in all types of projects, but is much less time-consuming (Bissonette, 2016). Other methodologies, as well as tools, should be used to complete a risk analysis, e.g. Monte Carlo, Risk Breakdown Structure, Checklists, etc.

3.1.7 Summary

Below follows a summary of the methodologies and standards:

Table 3: Summary of the Methodologies and Standards.

Methodology/Standard	Description
PMBOK®	The most common handbook to project management. Issued by the PMI.
ISO 31000-2009	An official standard on risk management.
AMA Handbook of Project Management	A handbook to project risk management issued by the American Management Association.
ATOM	A book describing a novel approach to project risk management.
GOWER	A book on project risk management. Follows a structure inspired by the PMBOK but has additional parts.
A Practical Implementation Approach by Bissonette	A book written by Bissonette. Takes a lot from the PMBOK but adds other authors experiences and knowledge to complete the PMBOK.

3.2 Techniques and Tools for Project Risk Management

This subchapter outlines the techniques and tools used in theory for project risk management. They are different from the handbooks and standards literature which display processes, while techniques and tools, as the name suggests, have a direct applicable usage within the processes. They have been sorted in alphabetical order and not according to importance or relevance for the study.

3.2.1 ABC/Pareto analysis

The Pareto analysis, similar to ABC analysis, follow the 80/20 principle which mean that 20% of something has 80% of the effect. While this is commonly used in quality management and inventory management, it can also help identify the main risks. It follows the same principle by identifying the 20% of the largest risks (Sarkar, et al, 2013; Li et al 2012).

Pareto analysis involves identifying the main risks, attributing a probability to them and then plotting them in a diagram. This is done by using a variety of mathematical formulas but can also have a qualitative input. The diagram would then show which

ones are causing the highest impact thus giving the manager a good place to start by focusing on them first. (Sarkar, et al, 2013; Li et al 2012).

3.2.2 Brainstorming

Brainstorming a common way to identify risks. The procedure consists of a number of people, preferably experts within different areas of expertise, identifying risks connected to the project. It is beneficial that these members have experience from previous projects. The brainstorming can be done in a structured interview form or a more free form (PMI, 2013).

Wood and Pickerd (2011) mention a number of things that might lower the accuracy of the brainstorming process. Amongst the things mentioned are social loafing, groupthink, evaluation-apprehension and distraction conflict. Rigie and Harmeye (2013) mention a number of way to increase the efficiency. In similarity to the PMBOK®, they suggest diversity amongst the participants but also suggest planning the brainstorming session to increase efficiency and setting rules.

3.2.3 Checklist

The checklist is a simple tool that provides a number of items which have to be checked during the course of the project (PMI, 2013). The content of the checklist should be assembled using experience and historical data, which should aid in identifying the necessary items. The checklist should be used to ensure that all known risks are planned for. It is important also to analyze the checklist to identify risks that are not in it. (PMI, 2013).

3.2.4 Decision tree analysis

The decision tree analysis method aim at establishing the potential estimated monetary value (EMV) of a project if certain decisions have been made. The tree is often graphically presented, similar to a flow chart, where each decision made takes on a different path. The combination of decision then leads to a certain outcome where a final EMV is presented. The decision tree can map out the effect of the risks and is often accompanied by a probability of occurrence which is derived from expert judgement and analysis of available data (Dey, 2012).

The decision tree is good for providing insight into the effect of decisions. For example, a decision could be whether a project should invest more money into a more thorough geotechnical examination of a construction site or not. One of the decisions will cost more but reduce the risk of stumbling across problems in the ground. The other choice is cheaper but has a higher risk of causing problems should the ground prove unruly.

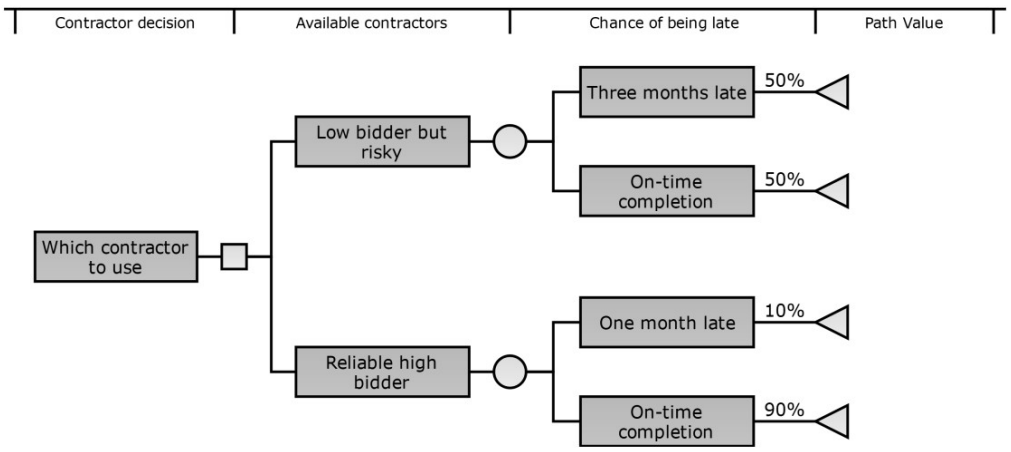

Figure 1: Example of a Decision tree analysis graph.

3.2.5 Delphi

The Delphi technique is a method of forecasting things that might happen during a project. It is based on expert judgement and is thus entirely qualitative. The process is based on using questionnaires in in order to extract the opinions on certain matters from the experts. The participants are then to answer the questions in the questionnaire, which is anonymous. Afterwards the answers are analyzed by the Delphi session leader who conducts the Delphi analysis and assembles it so that it can be presented statistically. The results are then shown to the participants, in hope that once they see the answers of their peers, they will change their own answers to coincide with the others. The process is repeated until the "best" answer is reached. An important factor here is to ensure that the answers given by the participants are motivated so that their peers can see why they think in a certain way. This might make them change their mind and converge towards the "correct" answer (Rowe & Wright, 1999; PMI, 2013).

3.2.6 Fault tree analysis

Fault tree analysis is a technique used to analyze system reliability. In the beginning a main event is chosen to be analyzed, for example a certain risk, then the event is followed by a number of potential causes going down in levels until the bottom or root cause is found. Again, probabilities are attached to each cause in order to easier create a picture of how high the chance of the occurrence is. The fault tree analysis is heavily based on mathematical formulas and probability theory and is therefore mainly a quantitative form of risk analysis. However, the identification of the top-level event or risk can potentially be qualitative (Huang et al, 2004).

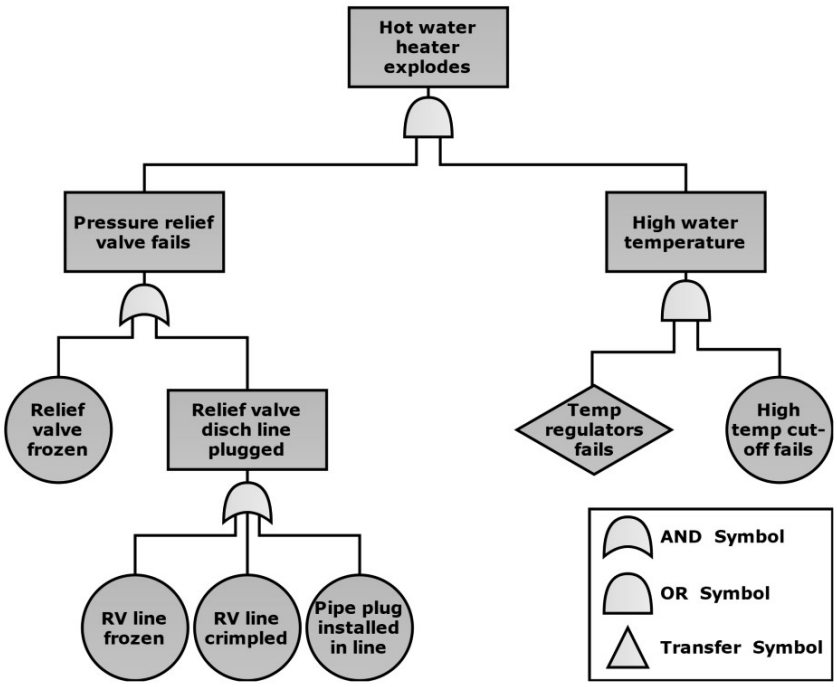

Figure 2: Example of a Fault tree analysis graph.

3.2.7 Monte Carlo

The PMBOK® (PMI, 2013) mention using Monte Carlo simulations as a tool to simulate the project and generate cost estimates, project time estimates and so forth. Alongside the generated estimates, a probability is generated, which tells how high the probability of achieving that particular estimate is. In general, the results are presented in a histogram or some other type of diagram. In order to be able to do a Monte Carlo simulation, a program capable of doing so is needed. The inputs used in order to produce the results can vary but in general they are various estimates such as cost, duration and time. The simulation then runs the variables many times with different setups in order to provide different results.

3.2.8 Risk breakdown structure

One very important tool for the project manager when administering risks is the Risk Breakdown Structure (RBS), which is a hierarchical method based on the Work Breakdown Structure which is often used in organizations (Viswanathan, 2016). The RBS is a way of sorting the risks into bigger categories as well as breaking down the main categories into smaller ones. This way it makes it easier to assess the causes of all the identified risks by creating an overview of the all the risks involved in the project. An RBS could become a powerful tool throughout the entire project due to its logical structure, and it can also be developed into a checklist if need be (PMI, 2013; Bissonette, 2016).

The purpose of an RBS is to easily manage huge amounts of lists containing different risks, and it creates a more holistic view as well as being able to go into detail (Hillson,

2003; Bissonette 2016). A qualitative approach cannot as easily identify hot-spots, but by structuring the data it becomes more obvious where to allocate the resources for the project. An example of an RBS is shown in fig. #, where the risks are located on different levels of subcategories, and this can be easily adapted to the companies' needs in which a different kind of sorting might be more fitting. Ones the RBS-template has been established, a quantitative approach can be made (Hillson, 2003; Bissonette, 2016).

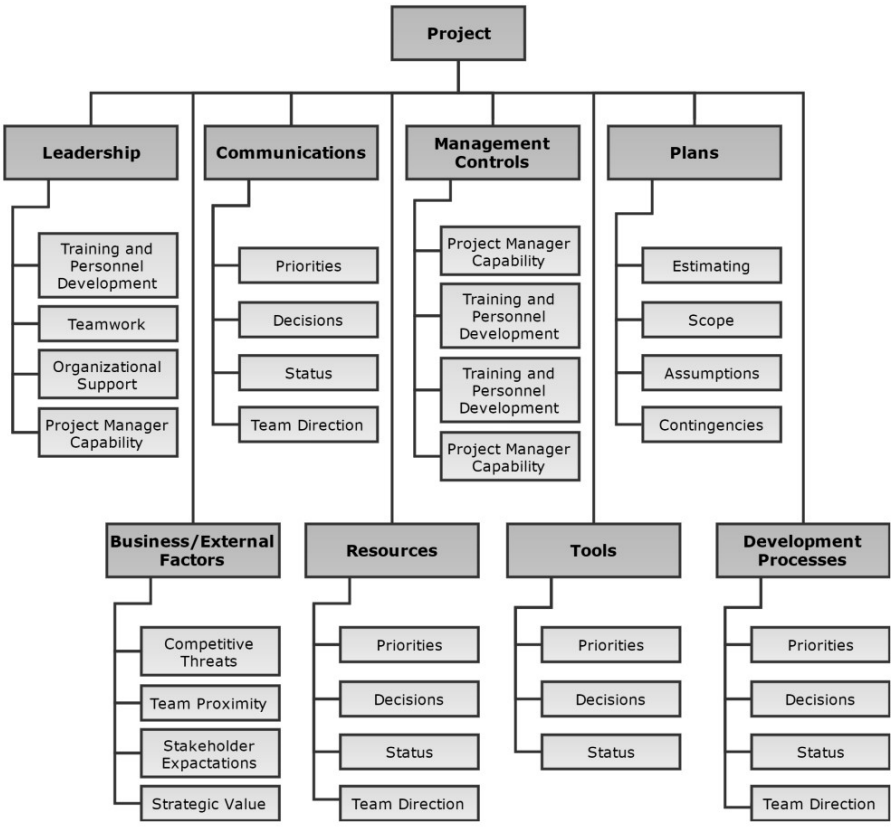

Figure 3: Example of Risk Breakdown Structure (Bissonette, 2016, aesthetically revised for the thesis).

3.2.9 Risk Matrix

According to the PMBOK® (2013), a risk matrix is a tool used to attribute risks their probabilities and impacts. The combination of the probability and the impact then results in giving the risks a value of importance, ranging from low, moderate to high. However, the range can be expanded if needed to provide a more detailed matrix. The risks and their impact are identified either qualitatively or quantitatively, or as a combination (Ni et al., 2010; Anthony & Cox 2008; PMI, 2013).

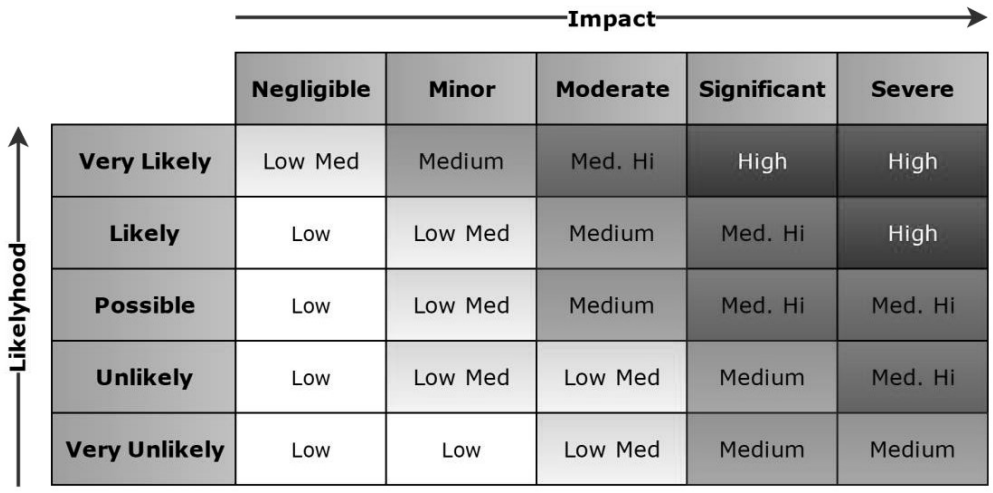

Figure 4: Example of a Risk matrix.

3.2.10 SWOT

SWOT (strengths, weaknesses, opportunities, and threats) analysis is a tool used to analyze businesses, projects and people in order to be able to make good decisions (Osita et al., 2014).. The SWOT analysis consists of four parts, strengths, weaknesses, opportunities and threats. In each of these categories, factors having that specific effect or potential are listed. The aim of the SWOT analysis is to provide a foundation for analytical decision making (Osita et al., 2014).

In the strength category, the strong sides are listed and subsequently the weakest sides under weaknesses. For example, a strength could be having strong finances in a company and a weakness could be weak finances. Typically, the items listed under strength and weakness are internal, coming from within the organization (Osita et al., 2014).

Under the opportunities and threats categories, external factors are listed. These are things that can potentially hurt or benefit the organization. For example, an opportunity could be a competing company going bankrupt and a threat could be a new player on the market (Osita et al., 2014; PMI, 2013).

3.2.11 Summary

Below follows a short summary of each of the tools and techniques.

Table 4: Summary of Tools and Techniques.

Tool/Technique	Description
ABC/Pareto Diagram	80/20 principle, identifying the 20% of risks that does 80% of the impact.
Brainstorming	A technique used to identify risks.
Checklist	Used as a planning tool to check risks that have been managed.
Decision tree	A technique for better decision making.
Delphi	A techniques used to identify and categorize risks by using expert knowledge.
Fault tree	A way to help understand the causes of certain risks and how to manage them.
Monte Carlo	A simulation that produces a large number of outcomes based on inserted variables.
Risk breakdown structure	A way of systematically breaking the risks into categories.
Risk Matrix	A tool for categorizing risks based on impact and probability. Used for prioritizing risks.
SWOT	A technique for identifying and categorizing risks.

3.3 Application in the industry of the tools, techniques and methodologies

In this chapter, the application of the methodologies, tools and techniques in the construction industry, will be presented with cases found on the internet. The objective is to show examples of how they can be applied to the construction industry. However examples of application in the construction industry for a few of the methods, tools and techniques, could not be found.

3.3.1 The PMBOK® in the construction industry

According to the PMBOK® for construction (PMI, 2008) the methodology described in the PMBOK® (PMI, 2013), is quite usable for construction projects. However, a number of changes must be made in order to make it more suitable for construction projects. One such things is consider the subcontractors and the impact they can have, which puts emphasis on efficient management of the subcontractors. The procurement phase is also important as it defines the contracts and responsibilities which in turn is important for risk response. Risk transfer is one such thing that might be decided upon in the contract. As construction projects often involve many stakeholders, often with

different goals and ambitions, using experts can pose a risk as it might allow the "expert" to make judgements that benefits their own interests (PMI, 2008).

3.3.2 The ATOM methodology in the construction industry

The ATOM methodology (Hillson & Simon, 2007) does not make any references to its application in the construction industry. However, it does describe how to apply it to large and small projects. Assuming constructions projects most often count as big, at least in the case when considerable risk management is applied, information can be extracted from the ATOM methodology.

When large projects are concerned, several issues need to be considered. For example, risks that appear due to the complexity of the projects and the involvement of several stakeholder such as subcontractors. One must also consider the legislative risks such as acquiring permits. The ATOM methodology also recommends using quantitative analysis for large projects. Simulation such as Monte Carlo might expose and help manage advanced risks.

3.3.3 SWOT applied in a construction project

Milosevic (2010), describes the use of SWOT analysis on a construction project in Belgrade, Serbia. The SWOT analysis identified a number of risks, both positive and negative. A few examples of negative risks identified were such as uncoordinated workers, workers' health risks and a high water level. Positive risk on the other hand were using a known subcontractor, skilled team and good contract terms. The risks were identified from the contractor's point of view.

Furthermore, Milosevic (2010) concludes that the SWOT analysis enabled many stakeholders to get a better grasp of the project scope and thereby reduces the uncertainty that is inherently a part of construction projects. This could in the end reduce costs and results in better building but also give certain stakeholders, such as the contractor, more influence into project decision making by referring to the SWOT.

3.3.4 Risk Matrix applied in construction

Mahamid (2011) describes the use of a risk matrix to manage project risks. In a road project in the West bank in Palestine. The article presents a risk matrix with several identified risks along with their impact and probability levels. The risks were identified and categorized using a questionnaire that was sent out to experts. Some of the greatest risk identified are poor work by the workers, poor communications and poor resource management. The risk matrix only takes negative risk into account.

3.3.5 Fault tree analysis in construction

In the article written by Abdollahzadeh and Rastgoo (2015), they performed a fault tree analysis on a bridge construction project. Using Delphi and expert judgement to identify risk and construct the top event of the fault tree, then they applied the formulas for calculations to perform the analysis. The analysis then resulted in a number of risks presented as events, such failure to set the proper bid price on the project and

weaknesses in the design. Afterwards the risk responses were planned by experts in the various fields. The article also suggests using Monte Carlo in order to simulate the various alternative events.

3.3.6 GOWER applied in construction

The GOWER handbook (Turner, 2016) describes the application of the GOWER guide on a large infrastructure project. Turner describes six complexities that are inherently part of a large infrastructure project. The complexities in such projects which can be viewed as a category of risks. Technical complexity for example consists of several risks such as the use of unproven technology. Each of the six categorizes present risks that have to be identified and manage accordingly. It appears obvious that the GOWER handbook does not clearly separate the risk management aspect from the more general project management. This coincides with the way most of the other handbooks treat risk management, a vital part of project management.

3.3.7 Decision tree analysis

Dey (2012) describes the risk analysis during the construction of an Indian oil refinery. The application of a decision tree analysis is included and the first step is to break down the project into smaller pieces in so called work groups, to enable a more detailed analysis. For each work group, a decision tree is established, detailing the various decision that can be taken. The decisions are coupled with a probability failure and no failure as well as the time and cost aspects for each item in the tree. This allows the manager to look at the tree and easily decide which route is the safest, fastest or cheapest but also to see the risk of choosing certain actions.

3.3.8 Risk Breakdown Structure

Sigmund, et al. (2014) suggest that RBS can be used in already existing construction projects and not only during the planning and initiation phase. A suggestion for developing an RBS as a tool for existing projects could prove useful, especially in areas prone to external risks.

Mehdizadeh, et al. (2011) suggested another application for RBS in which it is constructed and developed using constraints, making it into a dynamic tool that could take more aspects into consideration. This could prove a powerful tool in the construction industry which would result in an RBS containing a database which in turn could further be used in future projects and development.

4 Results

The data in this section is based on 14 interviews with people from the construction industry. The interviewees have ranged from project managers, to risk managers, to consultants within several project management disciplines, to CEOs and other mid managers. A criterion was that the person being interviewed has experience from working with risk management on a project level. The data has then been assembled into topics that were found to be the most relevant and common ones in relation to the aim and purpose if the thesis.

4.1 Risk management processes

Each interviewee described their own process. While many aspects were often shared amongst the procedures described by the interviewees, they did differ in some ways. The usual differences was in the way they performed the workshops, who was included in them, which tools they used and which type of risks they focused on.

Most contractors did not have a clear set out process that they followed. Instead it was highly depending on the project and the people involved. Most of the consultancy companies however had an established process that included tools and techniques as well as standardized procedures.

The most common aspect that was shared by most of the interviews was the workshop and use of spreadsheets, also known as risk registers, for listing risks. All companies mentioned that communicating with stakeholders is highly important in order to do a proper risk management. It is important to get the opinion of the people with most knowledge in a certain matter and therefore the responsible risk manager often works with experts in their particular field.

Appointing risk owners is also a common thing to do and is a way to ensure responsibility that the risks will be managed. However, it is often the project manager's responsibility to assure risk are managed.

The process, while not standardized in its application and documentation, included a few common parts. Risk identification was a part of all companies' risk management process, however there were several different ways to perform it. Brainstorming and interviewing were quite common. Risk response planning was done by most companies but some did not include any of the sort. Some had the risk responses incorporated into the risk register, documented in an Excel sheet, some did not document the responses but rather managed or implemented them into the project in other ways.

4.2 Different types of views on risk management

A large difference between the responses from the interviewees is their view on risk management. While some, mainly consultants, see risk management as something very important and necessary to do continuously throughout the project lifecycle, others, mainly contractors, see it more as something that has to be done to appease the client.

This difference in attitude is highly visible in the fact that the consultancies have a standardized process in most cases while the contractors are in the opposite.

Many of the contractors have expressed a need for standardization and larger focus on the risk management process but this remains a challenge considering the size of the organizations and the complex and diverse nature of projects. One contractor also described the challenge with a lack of competence for proper risk management throughout the organization which makes it even harder to implement a standardized process that is comprehended by all employees. Advanced tools such as Monte Carlo struggles to find a place in the industry much due to the lack of expertise and understanding of the tool.

4.3 Improving knowledge transfer

Almost all the companies mention the need for better knowledge transferring of previous projects risk management. What was currently considered knowledge management was the documentation of the project stages, as for what was done in the project as well as what went right and wrong. The use of this kind of documentation has no standardized approach more than that it is an obligation for the companies to document everything which revolves around the project.

The belief is that there is vital knowledge to be collected from previous projects which can be used for projects in the future. How this type of information is being transferred though, is often by expert judgement as well as informal conversations. Vital parts from previous projects are more of focus especially if a post-project analysis has to be done. Managing knowledge and learning in the organization is key to effective risk management according to some companies. Many of the interviewees state that experience from previous project enables companies to utilize their risk management in a better way catching more risks and producing better projects.

4.4 Risk management in the procurement stage

The procurement process is where both contractors and consultants can have the most influence on the process. First a contract must be won in the tender process, but even before the tender is delivered there is a bunch of conditions which must be met. The company must first contemplate the feasibility of the project they might be going into, where a plan involving risk is made. This process is different depending on the contract. In a case where there is a partnership between the companies they are in agreement where the responsibility is allocated. The distribution of responsibility is important when the companies agree on the contract, this mostly revolves around financial risks to mitigate penalties, both legally and contractual.

According to many of the interviewees, the processes which often has the most unpredictable risks are the ones dealing with the geotechnical conditions. These ones are hard to predict and very often because of the tender-processes' short timespan there is not much time to be had to fully investigate the geotechnical conditions. Some of the companies have a focus on risk management in the procurement stage, even before the

tender-process, where most of the risks are identified before the project execution. Other companies worked with risk management even further into the project stage as well as in the procurement stage. This varied from company to company, but they agreed on one common constraint, the more identified risks in the procurement process the more successful the project.

4.5 Tools and techniques used in risk management

The companies involved in this study use a number of different tool and techniques to aid them in their risk management work. The ones mentioned in this chapter are the most frequently mentioned during our interviews.

4.5.1 Checklists

The use of checklists seems to be widespread in the industry. Most companies mention using checklists for many different purposes one of them being in risk management. When used in risk management it was most of the time not used as a checklist for specific risks, as this might put limitations on the manager, but rather as a checklist for ensuring all things associated to the project were included and managed.

4.5.2 Spreadsheet

The most common way to collect and categorize risks, is to insert them into a risk management sheet. This is usually made in an Excel document, where the risks are named, described, action to manage it are written, and sometimes given a value of probability and/or impact level.

The spreadsheets that have been mentioned repeatedly during interviews are used in different ways. Some use them as a way to collect the risks so that it can be presented to stakeholders or to be used during bidding. Others use it as a way to document the risks and keep it updated during the project lifecycle. Yet another use of the spreadsheet was to use it as a checklist, but this way of using the sheet is mostly informal in order to get an overview of the risks.

4.5.3 Monte Carlo

Monte Carlo simulations were used by some of the consultancies as well as one of the contractors. The consultants used it as a part of their sell offer, which often included a broad set of tools and techniques as well as its application. The interviewee at a certain consultancy described the utilization of Monte Carlo as well as lack of understanding its use and potential gains from the industry. Other consultancies also applied it in some complex projects but some interviewees did not even know what it was. The only interviewee from a contractor that uses Monte Carlo did it as a part of their risk management system. However as pointed out by the interviewee, if the tool was used by someone lacking in experience and competence of risk management, it would sometimes result in the Monte Carlo simulation not utilizing the full risk spectrum but limiting to a narrow spectrum which misses a lot of important risks. Thus, the company

did only apply it to certain projects where the right competencies were found but also where the size of the project required it.

4.5.4 Risk matrix

Risk matrixes were also mentioned by several of the interviewees to be used by their company. The use was most often a way to categorize and quantify the risks. The probabilities and impact levels were the result of expert judgement. Most of the contractors used this only as a way of presenting risks to different stakeholders. A problem that was mentioned by some of the interviewees was that risk matrices were sometimes simply copied form another previous project with little thought and analysis put into it. Therefore, the risk matrixes are often not used as a way to manage risks rather than present the risks.

The calculations used to give a value to the risks is often lacking and sometimes non-existent. Calculating risks requires more effort and expertise to properly do so. Some companies did not even use risk matrixes due it seeing it being superfluous.

4.5.5 Risk breakdown structure

The RBS was one of the techniques that most companies used, in one form or another, but without using the specific name. For that reason, it is hard to know exactly how their RBS-equivalent worked and what it looked like. However, the information gathered during interviews shows that most companies do indeed categorize risks into larger categories which then is divided into several smaller ones connected to the larger category.

4.5.6 SWOT

SWOT analysis was used by some companies. At project level, it was mainly the consultancies that used it but at organizational level some contractors too. The SWOT analysis was mostly used as an internal process to help analyzing the project. In rare cases, it was presented to other stakeholders.

4.5.7 Workshops

A large part of the companies interviewed, use workshops as a way to manage risk. However, the workshops themselves look a bit different from company to company, the one common trait is that it serves as a way to gather a wide assortment of stakeholders to work with risks.

The most common way to work with workshops was to allow different parties involved in the project to express their view on risks. Here identification is done mainly through brainstorming but interviews is also used. Afterwards, the risks are summarized, often in a risk management plan in the shape of an Excel file. Once the risks are identified, an owner is appointed to each risk. The owner has the responsibility to ensure the risks are managed. Most of the time, the owner of a certain risk is someone who has expert knowledge in that area, for example geotechnical risks might be appointed to the geotechnical consultants. However, a few of the interviews mentioned that it is often

the project manager or the site manager who has the highest responsibility to ensure risks are managed.

The frequency of which the workshops are conducted varies with companies and projects. There has been mentions of workshops held on a monthly basis but also on a quarterly basis. The interviews also showed that the selection of participants varies depending on the current phase of the project as well as depending on project size.

4.5.8 Summary

Figure 14 shows a summary of the frequency of tools and techniques mentioned to be used in their organizations. It clearly shows that the most common approaches are *Brainstorming*, *Checklists* and *Workshops*. *Checklists* were the one method which seemed to be following the project manager's way of work while *Brainstorming* and *Workshops* where the type of technique used to involve the majority of the stakeholders for the projects.

Table 5: Risk management processes, tools and techniques used by interviewed companies.

Risk management processes/tools/techniques used by the interviewees	
Processes/tools/techniques	***Percent of the interviewees***
Brainstorming	100%
Checklists	91%
Workshops	91%
Risk Matrix	73%
Standardized process for PRM	55%
Monte Carlo	27%
SWOT	18%

5 Analysis

In this chapter, the data collected during the interviews will be analyzed in contrast to the frame of reference.

5.1 The industry's application of risk management

Risk management is a real thing within the construction industry. However, its application differs depending on project size and complexity. It seems from the interviews that many of the people working with risk management in the construction industry, are not familiar with methods and tools from the theory. Some tools and methods are used such as risk matrices and brainstorming but the overall methods described in the literature are not applied nor do the people conducting the risk management seem to pay attention to them. The general attitude of the industry seems to be simplicity first and as such most companies with the consultancies as an exception by using a bit more advanced methods, apply a simplified form of risk management, focused on expert judgement and listing risks in spreadsheets.

The companies in this study did not have a structured way of performing risk management more than that they had a risk register. There was rarely a clear process of how to proceed and what to include. The risk register which is a way of compiling risks along with probabilities and impact levels was used very commonly. However, the process of filling the plan rarely seems to be structured or systematic and can differ from project to project. Many have expressed a greater need to standardize the process, which in turn might improve the entire risk management. Other stated that there is no real need to standardize it because that might restrain the managers in their work by forcing them to follow a procedure that might take a lot of time and focus away from other tasks. However, when we consider that one of the greatest problems these organizations face is the knowledge transfer, a standardized process might sooth that problem by clarifying the process and documenting it properly.

The spreadsheets used by almost all companies are the same thing as the risk register mentioned in the literature. Surprisingly, the risk registers that were encountered during interviews all had a very similar appearance. Characterized by the Excel sheet with the risk descriptions followed by impact, probability, solution and budget. Many of the interviewees considered the risk register to be a solid tool for risk management. It provides a clear and easy to follow structure in organizing the risks. The potential problems that might arise here, especially when done by inexperienced managers, is that the risk register becomes too big with too many risks as a result of not knowing what to prioritize. This reduces the efficiency of the risk register making it cumbersome to handle. This in turn can lead to unwillingness to look at it or present a difficulty in communicating it to other stakeholders. Another common critique against it was that it could easily become too complex. Several companies had risk registers that included many categories, some that are quite abstract and subjective such as probabilities assigned without much thought given it. Due to the risk register often being in Excel sheet, it seems beneficial if the descriptions are short. While this does make it easier to

read, it can also lead to the risks being described poorly and as said before the reasoning or procedure behind some of the things such as probabilities and impacts not being clearly explained and motivated. This might seem as a minor issue but it is important to remember that this plan is the central piece of documentation of the risk management. A poor risk register can potentially lead to poor and unstructured risk management due to it causing difficulties in understanding and handling it.

5.2 Knowledge transfer

Knowledge transfer is a step in some of the methodologies such as Bissonette's, GOWER and ATOM. GOWER suggests conducting a what-did-we-learn meeting, where a number of questions around the project are answered in order to capture learning points. ATOM suggests a structured way of learning, through a post project meeting as well as compiling a complete risk list with all the managed risks in it. Bissonette (2016) called the post project meetings "postmortem", which is referred to as any completed project where the postmortem analysis copes with the project's harmful processes and occurrences. This knowledge is to be handled in a way which is adapted to the organization which will be using it. An example is a constant growing database of postmortem lessons learned. A difficult aspect here is that the data could be too overwhelming leading to that the people might take an easier approach through their expert's knowledge.

Comparing this literature to the industry, it is easy to see that the industry does indeed apply or at least tries to apply similar methods of capturing knowledge. A post project review meeting is conducted by some companies but it seems many companies do not do it. Another common issue is that the meeting rarely end up producing a documentation. In the cases where it does produce a document, it is rarely ever looked upon again. A stronger focus on these post project meetings and a more structured and strict documentation of the learning points might be something to look at for the companies seeking to improve their risk management process.

5.3 Simulations and other software

To begin with, the study was supposed to also find software used in the construction industry which managed risks specifically. The consultant companies had developed their own risk management software which they could sell as a service to the contractors. Only a few of the contractors interviewed had software associated with risk management. While most had internal systems that contained the risk management documentations such as the risk management plan and risk registers, as well as documentation software, but a software for risk management was rare. Those who did have software designated for risk management rarely used it as it was considered either unnecessary or too advanced.

Simulations seems to be rarely used amongst companies in this study. Many of the interviewees in this study had never even heard of the risk analysis simulations. However, the most commonly stated reason for refraining from using simulation

methods was that it was too complex and required specialized expertise that they did not have. It was also stated that the simulations were not trustworthy or did not provide anything of use to the projects but also that it took too much time to perform them. This gives a clear picture of the mentality of the industry, complexity is to be avoided and new methods that people are not used to using is also to be avoided.

Very few of the interviewees said they believed that there was any value to find in the simulations and that they believed it would be too complex to communicate through. Other interviewees explained that the simulations, even though seeming to be valid, might actually be not correct due to what type of input the simulation gets. The data which is being simulated must come from a reliable source, and that does not have to be the case, therefore it makes simulations flawed to start with because of the construction industry's way of work, it is unique in every project. Furthermore, a belief in that the simulations are a poorer version of the experienced manager's knowledge and skills is also commonly prevalent. Companies also have their own software which they have chosen to use for risk management, but if that software will deviate even the slightest in the future because of an update in either structure or method, it might be met with resistance from employers. The attitude towards change in the industry is there and needs to be taken into consideration when implementing new tools and methodologies.

5.4 Standardized methodologies

SWOT analysis was commonly used, nearly all interviewees said they to use it within their company. However, the big difference compared to the theory is that SWOT analysis is used on a higher organizational levels such as corporate levels and rarely on project level. The theory states that SWOT analysis is a good tool to work with in identifying project related risks as well. The reason most commonly stated for not using SWOT on project level is that it takes too much time to do. Many also do not see the need to implement it on project level, saying that current identification methods are sufficient. One could question this and claim that performing a proper SWOT analysis might in fact help in finding critical risks.

One of the most common ways of working with risk management is by conducting workshops. The workshops all have a similar procedure, the main difference is in the participants. According to several interviewees it is often preferable to include people of varying disciplines. This creates a better environment for identifying risk and solutions in all parts of the project. This coincides very closely to how the PMBOK says the qualitative analysis should be done. However, it is worth noting that the PMBOK only mentions using workshops in the qualitative analysis, not in the identification of risks. GOWER on the other hand does mention using workshops in both the identification phase as well as the qualitative analysis. On the other hand, the AMA risk handbook suggest using workshops only in the identification phase. The ATOM methodology follows the same path as GOWER. Bissonette's handbook does not mention workshops at all. So it can be seen that the different methodologies do not

agree on where and when to conduct workshops. Also, it is poorly explained on what type of workshops, who should be in it and how often they should be done. This goes perfectly hand in hand with the construction industry's way of doing it, it differs between companies and people.

The use of a Risk breakdown structure (RBS) was often limited to a means to create an overview of the risk situation by whoever was responsible for the risk management. The interviewees had never heard of RBS but rather assumed what Risk breakdown structure was based on its name. Nearly the same type of RBS-methodology was used in companies which basically organized risks into groups in order to create an overview of all the risks, which was actually the purpose of an RBS. The list of risks could be long, resulting in that the holistic view becomes limited to only the company's knowledge of the most critical risks, because they are the easiest to remember. Therefore, some companies had risks categorized and allocated different functions. The allocation of responsibility is also important both for the contractors and for the consultants, this is often in relation to the client.

6 Discussion

The Project management institute (2016) mention several reasons why most projects still fail to meet the set goals. One of the risks mentioned is the failure in applying formal project management techniques in risk management. Looking at the construction industry we see that many companies lack this very aspect, a formal, standardized process to manage risks.

According to Hubbard (2009) project failure could be a result of many factors, but the majority are related to the risk assessment where all the risks should have been included as well as having a response to each risk, theoretically resulting in risk mitigation. He also stated in his book "The Failure of Risk Management: Why It's Broken and How to Fix It" that the single biggest risk is that your risk assessment method does not actually work. This means that there is always a risk that your risk management method is flawed, it is again only as good as the human factor which it is managed by. There are ways to complement one's risk management process using other types of tools and methodologies (Bissonette, 2016), but the question is if it is worth to allocate extra resources into it and if it will actually work in practice. This is hard to predict and in specific cases it could not be known until a risk actually occurs.

The majority of the companies we have encountered often claim simplicity is the key to good risk management and that advanced tools such as simulations, risk confusing the people who are meant to work with the risks. The big question here is if the people working with the risks, workers, managers and others involved in the project, need to understand the process of how the risks were identified and analyzed. Simulations for example are a thing that can be hard to understand, but the results it presents are not harder to understand than those produced through softer methods of analyzing. Therefore, we see potential in applying more advanced methods in quantifying and analyzing risk, as long as the one performing the analysis has proper knowledge and experience. The results can then be presented in a simple form to ensure everyone understands them. We believe it is good to separate the process from the results in the way that the process can be advanced, if it yields better results, as long as the results can be presented in a simple form.

However, it is also questionable as to how practical the processes described in the literature are out in the industry. Projects are always unique and present unique circumstances in terms of budget, time and the project itself (PMI, 2013). This makes it harder to implement an entirely standardized system, which not only has to be adaptable to all projects but also has to be simple enough so that all managers can use and understand it. This puts heavy focus on flexibility and simplicity of the process which might not be the easiest thing to do.

A different approach might be to have a specific risk manager responsible for the risk management. This would allow a higher level of specialization for a few people which enables them to go into more advanced methods without having to worry about the complexity. Having a dedicated risk manager would also alleviate the managers by

removing the need to focus on risk. This would enable them to focus on other aspects of project management and receive the risk manager's documents and plans. The downside with this approach is that it may end up costing more money for the company but also that it might potentially disconnect the risk manager and the project manager from each other. Therefore, a solution like this would require strong collaboration between risk manager and project manager and involve other critical actors in the process so that the quality of the risk management can be ensured.

The general perception of risk management identified during the interviews is that it is something quite intuitive and dynamic, which explains why none has heard of any of the literature and very few of the tools and techniques. It is simply seen as something that does not need fancy software or a large bunch of documentation. Meetings and workshops where everyone gets a word is sufficient in most projects and the simplicity is something that is appreciated by most stakeholders. This aversion to complexity explains why the risk management process looks the way it does, basic and qualitative. There isn't much focus on calculating correct probabilities or impacts, what experience says is often enough or at least considered to be. In the end, risk management is all about making projects succeed, and probability-calculations might be a way to go. But the prioritizing system which is then being used after the probability-calculations, is based upon expert judgement, which is only as good as the person making the decision to put a risk on low or high priority. In this case, there is always a chance that a person's bias might cloud their judgement. However, having a structured process in identifying and managing risks is probably beneficial for the overall performance of the project and the risk management. It might enable more accurate analyses of risks, better identifications and smarter prioritizations.

The responsibility of risks goes together with the mitigation stage of risk management, where there is a person or function which is capable of handling the risks they are responsible for (PMI, 2013). The common approach, to delegate responsibility according to many of the interviewees, is to give it to the person which could handle the risks the best way. The geotechnical risks should be handed to the person possessing the most knowledge and experience in handling this type of risk, this is once again an approach which focuses on expert judgement. In most companies, it will often be the project manager's job to manage the risks based on their knowledge. The main reason responsibility is being managed this way is mostly due to the legal difficulties which might appear if an incident occurs, often resulting in a financial backlash, and there is no one to take the blame. No one wants the responsibility in this matter due to, as mentioned, the financial penalty for the company. The interviewees mentioned that no person wants to take responsibility for anything bad which has happened, and that people often look after their own skins than others, especially if those 'others' are not colleagues. In this, the risks would indirectly be on a higher priority list for the person responsible than it would be if it would not affect the person responsible at all. Even during negotiations, before project execution, the responsibility delegation must be handled in such a way that negative risks has the least chance to occur.

7 Conclusion

The purpose of this study was to investigate how people in some construction companies work with risk management and then compare it to a frame of reference containing literature and tools and techniques from the field of project risk management.
The study aimed to answer the following research questions:

- How do companies perform risk management on construction projects?
  - What tools and techniques are used?
  - Do companies use a certain standardized process for risk management?
- Can the processes used by companies be improved with support from literature?
- What can be added to the literature in order to provide a more complete picture of project risk management?

In conclusion, simplicity reigns supreme. The attitude in the industry is that simplicity is the way to go and advanced tools and methods are to be avoided. The aversion to complexity is not that surprising considering that the construction industry is a communication heavy industry due to it being project based. This requires tremendous communication efforts to ensure understanding and unity in the projects. Therefore, it is of grave importance that everyone, or at least the main players, comprehends all aspects of the project. Risk management is no exception, in order to ensure overarching understanding, it must be kept simple and easily understood.

The study showed that a common approach to project risk management in the construction industry is to conduct workshops where people with from different disciplines identify and discuss risks. These risks are then collected in a risk register along with risk treatments. Risk matrixes are also commonly used as a tool for prioritizing the risks by assigning the risks probabilities and impact levels.

However, when it comes to the process of risk management, there is room for improvement. Standardizing and systemizing the procedure could benefit the companies and the industry as a whole by enabling better and more accurate risk handling, which in turn may lead to increased profitability. There is also potential of improvement in using software that utilizes statistical data and simulations to give a more accurate spectrum of probabilities.

Risk management is something which is known both in academia as well as in the construction industry, but its definition and the way it is managed varies to an extent depending on what type of company you will be looking at. The contrast between the theoretical methodologies, tools, and their practice is vast, most of the companies have never heard of the majority of the theories used in risk management. The study compiled an amount of more known methodologies and tools which, in theory, is being used or showing promise to be used in the construction industry.

What should be added to the methodologies from the industry itself is the need for simplicity and personal experience and knowledge. The focus on keeping it simple is probably a result of lack of specialization but it also enables a stronger commitment from several disciplines to engage in risk management. Professional knowledge is also highly important and should not be forgotten. It is therefore important to focus more on documenting and transferring knowledge and experience.

7.1 Future research

Several questions can be researched more. Listed below are a few ideas the authors of this study found interesting for future research:

- Investigate the usage of simulations and other types of software in the construction industry. Can it be applied in a better way and is there a realistic possibility to make the industry to adopt these types of risk management tools in their usage?

- Conduct research on how to easier standardize and structurize the process of risk management, adapted to the construction industry. This would require a new approach and attitude towards risk management that relies heavily on being flexible and user friendly, as well as being prepared to utilize new tools and software to increase efficiency and accuracy.

- A suggestion for a framework is to develop it while bearing in mind that the easier it looks and feels the more likely it would be to follow. What needs to be avoided is yet another handbook being made to then be analyzed by a set of workers which are looking for something easy to implement into their company.

8 References

Abdollahzadeh, G. & Rastgoo, S. 2015, "Risk Assessment in Bridge Construction Projects Using Fault Tree and Event Tree Analysis Methods Based on Fuzzy Logic", *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering,* vol. 1, no. 3, pp. 031006-031006-12.

Andersson, B.E, 1985, Som man frågar får man svar. *Kristianstads Boktryckeri AB*.

Anthony, T & Cox, L. 2008, "What's Wrong with Risk Matrices?", *Risk Analysis,* vol. 28, no. 2, pp. 497-512.

Bevan, M.T. 2014, "A Method of Phenomenological Interviewing", *Qualitative Health Research,* vol. 24, no. 1, pp. 136-144.

Project Management Institute 2013, *A guide to the project management body of knowledge (PMBOK® guide),* Fifth edn, Project Management Institute, Inc, Newtown Square, Pennsylvania, (e-book collection).

Bissonette, M. 2016, *Project risk management: a practical implementation approach,* Project Management Institute, Inc, Newtown Square, Pennsylvania, (e-book collection).

Bryman, A. & Bell, E. 2015, *Business research methods*, 4.th edn, Oxford Univ. Press, Oxford.

Dinsmore, P.C. and Cabanis-Brewin, J., 2006. *The AMA handbook of project management*. AMACOM Div American Management Association.

Dey, P.K. 2012, "Project risk management using multiple criteria decision-making technique and decision tree analysis: a case study of Indian oil refinery", *Production Planning & Control,* vol. 23, no. 12, pp. 903-921.

Gillham, B, 2005, Research *interviewing: the range of techniques,* Open University Press, New York;Maidenhead, Ebook Central (e-book collection).

Hillson, D. 2003, "Using a Risk Breakdown Structure in project management", *Journal of Facilities Management*, vol. 2, no. 1, pp. 85-97.

Hillson, D., Simon, P., 2007, *Practical project risk management: the ATOM methodology,* Management Concepts, Vienna, VA, Books24x7 (e-book collection).

Huang, H., Tong, X. & Zuo, M.J. 2004, "Posbist fault tree analysis of coherent systems", *Reliability Engineering and System Safety,* vol. 84, no. 2, pp. 141-148.

Hubbard, D.W., 2009. The failure of risk management: Why it's broken and how to fix it. John Wiley & Sons.

Project Management Institute, 2007; *Construction extension to the PMBOK® Guide third edition,*;3rd; edition, Project Management Institute, Newtown Square, Pa, Books24x7 (e-book collection).

ISO 31000, 2009. ISO 31000:2009 Risk management - Principles and guidelines. [online] Available at: https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-1:v1:en [Accessed 26 Apr. 2017].

Kahneman, D; Tversky, A, 1977. "Intuitive prediction: Biases and corrective procedures" (PDF). Decision Research Technical Report PTR-1042-77-6. In Kahneman, Daniel; Slovic, Paul; Tversky, Amos, eds. (1982). *Judgment Under Uncertainty: Heuristics and Biases*.

Li, F., Xianyi, G. & Xin, M., 2012, "on reasons of uncontrollable construction cost based on the ABC analysis method and the complete decomposition model", *Systems Engineering Procedia,* vol. 4, pp.

Lind, H., Brunes, F, 2015, "Explaining cost overruns in infrastructure projects: a new framework with applications to Sweden", *Construction Management and Economics,* vol. 33, no. 7, pp. 554-568.

Mahamid, I. 2012;2011;, "Risk matrix for factors affecting time delay in road construction projects: Consultants' perspective", Trans Tech Publications Ltd, Zurich, pp. 244.359-365.

Mehdizadeh, R., Breysse, D. & Chaplain, M. 2011, "Modeling methodology of the Risk Breakdown Structure for project risk management in construction", , pp. 811.

Milosevic, I.N. 2010, "Practical Application of SWOT Analysis in the Management of a Construction Project", *Leadership and Management in Engineering,* vol. 10, no. 2, pp. 78-86.

Ni, H., Chen, N. & Chen, A., 2010, "Some extensions on risk matrix approach", *Safety Science,* vol. 48, no. 10, pp. 1269-1278.

Osita, C., Idoko, O. R., & Justina, N. 2014. Organization's stability and productivity: the role of SWOT analysis an acronym for strength, weakness, opportunities and threat. *International Journal of Innovative and Applied Resources*, *2*(9), 23-32.

Project Management Institute, 2016. *The high costs of low performance : How will you improve business results?*

Rachev, S.T., Stoyanov, S.V. and Fabozzi, F.J., 2011. *Risk and Uncertainty* (Vol. 211). John Wiley & Sons.

Rhoads, M. 2010, "Face-to-Face and Computer-Mediated Communication: What Does Theory Tell Us and What Have We Learned so Far?", *Journal of Planning Literature,* vol. 25, no. 2, pp. 111-122.

Rigie, M. & Harmeyer, K. 2013, "Seven ways to innovate your brainstorms for better results", *The Journal for Quality and Participation,* vol. 36, no. 3, pp. 34.

Rowe, G. & Wright, G. 1999, "The Delphi technique as a forecasting tool: issues and analysis", *International Journal of Forecasting,* vol. 15, no. 4, pp. 353-375.

Sarkar, A., Mukhopadhyay, A.R. & Ghosh, S.K. 2013, "Issues in Pareto analysis and their resolution", *Total Quality Management and Business Excellence,* vol. 24, no. 5-6, pp. 641-651.

Sigmund, Z. & Radujković, M. 2014, "Risk Breakdown Structure for Construction Projects on Existing Buildings", *Procedia - Social and Behavioral Sciences*, vol. 119, pp. 894-901.

Turner, R., 2016, *Gower Handbook of Project Management,* 5th edn, Taylor and Francis, Farnham, Ebook Central (e-book collection).

Viswanathan, B., 2016. *Understanding the Risk Breakdown Structure (RBS)*. [online] Project-Management.com. Available at: https://project-management.com/understanding-the-risk-breakdown-structure-rbs/ [Accessed 20 Feb. 2017].

Wood, D.A. & Pickerd, J. 2011, "Problems to avoid when brainstorming fraud risks", *The CPA Journal,* vol. 81, no. 4, pp. 64.

9 Appendix

The interviews were held in Swedish. **9.1** is the version used, **9.2** is a translation.

9.1 Interview questions (Swedish)

Vägledande frågor

1. Vem är du och vad är din bakgrund?
2. Hur viktigt anser du/företaget att riskhantering är?
3. Hur mycket tid lägger ni på riskhantering?
4. Vilka typer av risker brukar ni identifiera? (Identification)
5. Hur brukar ni planera att hantera riskerna? (Response)
6. Hur följs hanteringen upp? (Implementation)
7. Uppdateras riskplanerna genom projektets gång? (Monitor and Control)
8. Tar ni lärdom av föregående projekt för framtiden? (Knowledge)
9. Dokumentering (Risk management plan)?
10. Ser ni några möjliga förbättringar?
11. Specifika metoder, processer: SWOT, RBS, PMBOK?
12. Använder ni någon form av simulering? Monte Carlo?

Vilken av dessa metoder känner ni igen/använder?

1. SWOT
2. Risk Breakdown Structure
3. PMBOK
4. AMA i risk
5. DELPHI
6. Checklist
7. Brainstorm

9.2 Interview questions (English)

Guiding questions

1. Who are you and what is your background?
2. How important do you/the company believe risk management is?
3. How much time is spent on risk management?
4. What types of risks do you usually identify? (Identification)
5. How do you usually plan to manage the risks? (Response)
6. How do you follow up on the risk management? (Implementation)
7. Does the risk plan get updated through the project? (Monitor and Control)
8. Do you use knowledge from previous projects for future ones? (Knowledge)
9. Documentation (Risk management plan)?
10. Do you see any possible improvements?
11. Specific methods/processes used: SWOT, RBS, PMBOK?
12. Do you use any form of simulation? Monte Carlo?

Which of these methods do you recognize/use?

1. SWOT
2. Risk Breakdown Structure
3. PMBOK
4. AMA in risk
5. DELPHI
6. Checklist
7. Brainstorm