



CHALMERS
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Comparing Prescriptive Risk Management Processes against Practice

A case study of Veidekke's risk management system and procedures

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

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MASTER'S THESIS BOMX02-16-80

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ABSTRACT

Risk and risk management is part of most industries and companies. Within the construction sector, many projects are unique which makes them complex and influences the time and cost one need to put on risk management. However, risk management within many companies are limited and companies do not always put enough effort on risk management. In collaboration with Veidekke Entreprenad AB, an investigation and benchmark of their current risk management process and the work that their employees carry out will be analysed against prescriptive risk management processes (RMPs).

Most definitions of risk management include the aspects of a systematic process. However, this study has shown that the different prescriptive RMPs which has been studied is essentially a refined structure of common sense. Moreover, even if different layouts and names are used, prescriptive RMPs usually include the different phases of planning the RMP, risk identification, risk analysis, plan of risk response, and finally monitor and control of risks.

Veidekke's risk management has a similar setup as the prescriptive RMPs, but it is simpler and the transition between the phases are not as well-defined. During the interviews it was revealed that the interviewees work with risks and risk management, but not fully according to Veidekke's RMP. Some tools from the RMP are used, but most of the interviewees had their own way of performing the risk management. The work gets done, but maybe not in Veidekke's intended way.

The thesis has also studied the human aspect in the RMP: It can be established that an organization will be depended on the individuals performing the work. Different persons and different groups behave differently, approaches risks differently, and take decisions in different ways.

This study has shown that the interviewees vaguely implement Veidekke's intended RMP. In order to improve Veidekke's RMP and to make sure the employees can use it, this study has shown that the RMP need to be reformed with a clearer structure, and simplifying the documents which are to be used in the process.

Key words: risk, management, process, uncertainty, human, decision, decision-making, construction

Jämförelse mellan normativa riskhanteringsprocesser och praktik
En fallstudie av Veidekke's riskhanteringssystem och metoder

Examensarbete inom masterprogrammet Design and Construction Project Management

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SAMMANFATTNING

Risker och riskhantering är en del av de flesta industrier och företag. Många projekt inom byggsektorn är unika vilket även gör dem komplexa. Detta leder till både tid och pengar måste användas för att hantera risker. Trots denne kännedom finns det tendenser att företag lägger begränsat med resursers på att hantera dessa risker. I samarbete med Veidekke Entreprenad AB kommer en benchmark att genomföras på deras befintliga riskhanteringsprocess (RHP) och arbetsmetoder mot normativa RHP.

De flesta definitioner på riskhanteringsarbete betonar aspekten av en systematisk process. Det framgår genom litteraturstudien att även om de normative RHP beskriver sin process med olika utseenden och termer, så finns det stora likheter bland vilka delar som processen skall innefatta. Huvudinnehållet av de studerade RHP kan där med sägas innehålla en planeringsfas, en identifieringsfas, en analysfas, planering av riskåtgärder och slutligen en kontroll- och övervakningsfas. Det framgår även genom litteraturstudien att överensstämmelsen mellan RHP existerar på grund av att samtliga processer härstammar från samma riskhanteringsstänk. Litteraturstudien menar på att RHP sedermera är förädlade tankar som ledare har använt sig av under en längre tid.

Veidekkes RHP har stora likheter till de normativa RHP. Veidekkes process är enklare beskriven än de normativa och skillnader i strukturen har påträffats. Det upptäcktes under intervjuerna att intervjutagarna arbetade med risker och riskhantering men inte i enighet till det sätt som deras RHP beskriver. Intervjutagarna beskriver att de använder en del av de verktyg som presenteras i Veidekkes RHP, men till största del används egna rutiner. Således har det påträffats att intervjutagarna hanterar risker men inte på det systematiska sätt som Veidekke beskriver att det skall genomföras på.

Uppsatsen har även studerat den mänskliga faktorn i RHP. Det kan konstateras att organisationens nivå på dess riskhanteringsarbete är beroende av individernas prestation. Olika personer och grupper beter sig olika, hanterar risker olika och skiljer sig i sina beslutstaganden.

Studien kan visa på att intervjutagarna inte i en större utsträckning använder sig av den RHP som har presenterats för dem. För att förbättra den tillgängliga processen och för att öka de anställdas nyttjande av den, bör Veidekke omvärdera den befintliga processen med tydligare struktur samt förenklade de verktyg och dokument som skall användas.

Nyckelord: risk, hantering, process, osäkerhet, mänsklig, beslutsfattande, bygg, sektor

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Preface

This master's thesis is the result of our final course during the education of Master of Science in Civil engineering at Chalmers University of Technology in Gothenburg. The thesis is also the closing part of the Master's program Design and Construction Project Management.

The master's thesis was conducted during the spring of 2016 in collaboration with Veidekke Entreprenad AB. We want to express our gratitude to our supervisor at Veidekke, Stephan Woodbridge, for giving us the opportunity to carry out the thesis and for valuable information and experience from the industry. We would also like to thank the interviewees for participating in this study.

We would also like to thank our supervisor Mathias Gustafsson, Associate Professor at the division of Construction Management at Chalmers University of Technology. It has been a joy to work with you and to get your input in the creation of this Master's thesis.

Gothenburg, May 2016

William Dahlström and Alexander Liljenhed

Dictionary and glossary

The following words translates certain construction sector terms and/or words from English to Swedish and vice versa.

English (alphabetical order)

Execution plan
In-house inspections
Inspection plans
Operational manager
Operational system
Planning
Procurement/tender calculator
Site manager
Site supervisor
Tender
Work task
Occupational Health and Safety (HSE)

Swedish

Arbetsberedning
Egenkontroller
Kontrollplaner
Arbetschef
Verksamhetssystem
Projektering
Kalkylator i anbudsfasen
Platschef
Arbetsledare
Anbud
Arbetsmoment
Arbetsmiljö- och säkerhetsfrågor

1 Introduction

This chapter will introduce the topic of risk and risk management to the reader and describe the purpose and specific objectives this master's thesis aims to reach. Limitations with the master's thesis will be explained, and lastly the method.

1.1 Background

Risks and risk management is a part of most industries and companies, and the construction sector is one of those where risks are a large part of the profit structure of the company (Al-Bahar & Crandall, 1990). However, risk management within many companies is limited. Companies display an attitude where there is not enough time to put effort in investigating risks. Contradictory, if a risk occurs, there is time and money available to correct the consequence which arose (Smith et al., 2006).

Projects within the construction sector is often unique, giving a complexity where the amount of risks and type of risks differ. A definition of a risk in a project context is that risk *“is the chance of something happening that will have an impact upon objectives”* (Cooper et al., 2005, pp 3), common for all risks it that each risk has a probability of occurring, as well as a magnitude of severity if it were to occur (Winch, 2010).

Managing risks is focused on minimizing threats while maximizing opportunities (Hillson, 2003). The Risk Management Process (RMP) further aims to identifying the risks for a project, and then analyse them, to make the risks manageable (Hillson 2003; Zou et al. 2007). A respond for each risk should then be taken, before the final part of monitor and control of risks is initiated (Project Management Institute (PMI) 2013; Chapman 1997; Al-Bahar and Crandall 1990).

People perceive risk differently, which make them either risk averse or risk takers (Smith et al., 2006). This makes the risk management work more difficult since it is not only sufficient to create a good framework of tools and procedures, but it also relies on the individuals and groups performing the RMP. The human aspect is therefore an important aspect of the decision-making process of risk management.

The thesis has been conducted in collaboration with Veidekke, Scandinavia's fourth largest construction company having about 7000 employees (Veidekke, 2016b). Veidekke specialises in three areas, being road and infrastructure projects, buildings, as well as property development (Veidekke, 2016a). This study has been in collaboration with Veidekke's building business area.

1.2 Purpose

The purpose of this master's thesis is to examine the risk management process (RMP) at Veidekke in order to analyse it and compare it to existing literature and research in the area, and also to investigate the perception and usage of Veidekke's RMP by the employees.

The human aspect and how individuals perceive risk will briefly be described in order to understand how people can see risk from different perspectives, and how behaviour theories can explain groups and individual's performance.

The thesis aims at delivering useful information and knowledge to Veidekke in order for them to improve their RMP in future projects. In order to reach the purpose, specific objectives have been established:

1. Present and analyse prescriptive processes within risk management.
2. Present human aspects/factors that could influence the decision-making process.
3. Case study
 - a. Investigate and present Veidekke's currently used RMP based on their operational system.
 - b. Interviews in order to gain an understanding of the employees' perception of the RMP used at Veidekke.
 - c. Comparison between prescriptive RMPs and Veidekke's RMP according to their operational system as well as the employees' perception.

1.3 Limitations

Since this master's thesis was conducted during a limited time, limitations in the amount of RMPs to include in the comparison was restricted to three RMPs, these being:

- "A guide to the project management body of knowledge" (PMBOK) (PMI, 2013).
- Summarisation of "The Project Risk Analysis and Management" (PRAM) (Chapman, 1997).
- "Construction Risk Management System" (CRMS) (Al-Bahar & Crandall, 1990).

These three processes have been chosen to represent a broad view of different RMPs in order to make a fair comparison between Veidekke's RMP and the literature. The analysed RMPs are published over a wide time-frame, being 1990, 1997, and 2013. Two of them are also general RMPs while the RMP by Al-Bahar and Crandall (1990) is focused on the construction sector, which this master's thesis also has its focus on.

The amount of interviewees is merely a small number of the large organization which was studied, and the results and conclusions which can be drawn are therefore limited. For a deeper and more precise understanding, more interviewees would be preferred. Furthermore, the thesis focus on the perception of the employees' risk management work based on interviews. Hence, the risk management work that the interviewees conduct during a specific project or certain meetings during a project has not been followed.

There are several factors that might influence the RMP and the individuals performing it, this thesis focus on theories of how people and groups perceive and/or work with risks and decision-making.

1.4 Method

In order to fulfil the purpose, this study began with a literature review. The literature review lay the foundation and gave an understanding of the most important aspects in the study. Furthermore, via the literature review a better understanding of Veidekke's RMP could be made and questions for the interviews could be established.

1.4.1 Literature review

The literature study was conducted through two approaches. In the first approach, a regular literature research was initiated by searching in databases provided by Google scholar and the Chalmers library. In order to find the appropriate literature for risk management, key words such as "risk", "management", "process", "tool", "uncertainty", "construction", "human", "aspect", "risk", "factor", "decision", "decision-making", and "groupthink" have been used. The second approach was to search in the reference lists of the books and articles that were already found in order to find additional related literature.

In the searching for different RMPs, three specific RMPs were chosen. The RMPs chosen were referred in multiple context of other literature, which is why they are perceived as to be prescriptive processes. During the literature review of the chosen RMPs, it became clear that they all had similar approaches of how to perform the risk management work. However, even though the information and content of the RMPs were quite similar, they still differed in the way they were presented and the amount of steps which one need to work through. To easily present and compare the RMPs, the authors of this master's thesis have interpreted the RMPs steps and put them into different phases. The interpretation is further described and visually presented in Chapter 2, and in particular Section 2.4.

1.4.2 Case study

The case study constituted an investigation of Veidekke's RMP. Their operational system regarding risk management was analysed and compared with the prescriptive RMPs, in order to find similarities and differences.

Veidekke's operational system

The initial work was to understand the setup of the RMP and to describe it, so that it further could be analysed and compared to the prescriptive models. The operational system regarding Veidekke's RMP was read and summarized. A walkthrough was also given during an interview with the one responsible for Veidekke's RMP as described in the operational system. The RMP explained in the operational system was simplified in order to facilitate an easier understanding to the reader. The information was also divided into different phases as the prescriptive RMPs describe it. These phases could be observed in the operational system, but was not explicitly written out as different phases as the prescriptive RMPs. This was also done in order to simplify the information to the reader, as well as to make a better comparison to the RMPs found in the literature. This will further be discussed in the discussion found in Chapter 4.

Interviews

The interviewees were chosen based on their position, and with the desire to get a broad perspective of the organisation. This ended up in a total of eight interviews, which had the following positions in the organization:

- Two operational managers
- One sustainability manager, responsible for the RMP in the operational system
- One project manager
- One project engineer
- One calculator
- One site manager
- One legal expert, hired consultant by Veidekke

Prior to the interview, the interviewee was given a small description of the master's thesis and its purpose. A semi-structured interview method was further used. Hence, questions were prepared and followed, but the interviewee was to some extent allowed to diverge from them. The questions which were asked can be found in the Appendix 1.

The interviews were recorded and later on transcribed in order to facilitate easy access to citations and a better understanding of the interview.

2 Literature Review

A risk can be defined in many ways, PMI (2008, pp 11) defines it as “*an uncertain event or condition that, if it occurs, has an effect on at least one project objective... A risk may have one or more causes and, if it occurs, it may have one or more impacts.*” Furthermore, any risk in a given project will have a probability of occurring, and a magnitude of severity if it occurs (Winch, 2010). If risks are not managed properly, they could have devastating effects on project objectives in terms of time plan, cost overruns and/or quality. However, as Smith et al. (2006) explains, the difference between a successful project and a project disaster is far more complex than just applying a risk management process or not. Even so, it has been identified that if a certain project adapts certain risk management tools or processes, the chance of a successful project increases (Smith et al., 2006).

According to Smith et al. (2006), one must realize that even if risks occur at random it is important to seek the root of the risk so that it can be managed properly. If the cause of a risk happening is found, it could be managed in a way so that its chance of occurring decreases, or that it does not affect the project as much as if the risk would not have been managed. Risk that could occur in a project are many, examples of these could be risks relating to the project organization, design, logistics, inflation, construction materials, or construction labour (Perry, 1986). Others could be variations by the client, project funding problems, tight project schedule, or low management competency of subcontractors (Zou et al., 2007).

2.1 Risk management definition

Risk management can be used in different ways depending on the organization or projects a business operates within. Most definitions of risk management include the aspects of a systematic process consisting of identifying, analysing, and then responding to risks (Al-Bahar & Crandall 1990; Hillson 2003; PMI 2013). Other definitions bring up the risk management processes as a way to deal with uncertainties in order to minimize the threats and maximising opportunities (Zou et al., 2007), or that risk management is about avoiding, reducing, absorbing, or transferring risk (Wideman, 1992).

2.2 Definitions of risk and uncertainty

Risk and uncertainty is two conceptions that are often referred to together, and sometimes used to describe one another, but it is, however, important to understand how they relate to each other (Al-Bahar and Crandall 1990; Cleden 2009; Cooper et al. 2005; Klemetti 2006; Smith et al. 2006; PMI 2008). In order to get a better overview of the different definitions, a table has been established based on a literature research.

Table 1 below presents uncertainty, risk, and if the author has defined a relation between them.

Table 1: Different definitions of uncertainty and/or risk, as well as the defined relation between the two if available.

Author	Uncertainty	Risk	Defined relation
Smith et al. (2006, pp 3-4)	<i>“Uncertainty exist when there is more than one possible outcome of a course of actions but the probability of each outcome is not known (frequently termed estimation uncertainty).”</i>	<i>“Risk exist when a decision is expressed in terms of a range of possible outcomes and when known probabilities can be attached to the outcomes.”</i>	<i>“The understanding of risk implies that there is some knowledge about a risk as a discrete event or a combination of circumstances, as opposed to an uncertainty about which there is no knowledge.”</i>
Cleden (2009, pp 5)	<i>“Uncertainty is the intangible measure of what we don’t know.”</i>	<i>“Risk is the statement of what may arise from that [referring to the “don’t know” from uncertainty] lack of knowledge. “</i>	Risk is described by using the context from uncertainty, saying that risk arise from the lack of knowledge originating from “what we don’t know”.
Al-Bahar & Crandall (1990, pp 534)	<i>“The probability that an event occurs; thus a “certain” event has no uncertainty.”</i>	<i>“The exposure to the chance of occurrences of events adversely or favourably affecting project objectives as a consequence of uncertainty.”</i>	<i>“Risk = f(Uncertainty of event, Potential loss/gain from event).”</i>
Cooper et al. (2005, pp 3)	No definition of uncertainty mentioned.	<i>“Risk is exposure to the consequences of uncertainty. In a project context, it is the chance of something happening that will have an impact upon objectives. It includes the possibility of loss or gain, or variation from desire of planned outcome, as a consequence of the uncertainty associated with following a particular course of action.”</i>	No defined relation mentioned.
Klemetti (2006, pp 84)	No definition of uncertainty mentioned.	<i>“An uncertain event or condition that results from the network form of work, having an impact that contradicts expectations.”</i>	No defined relation mentioned.
PMI (2008, pp 11)	No definition of uncertainty mentioned.	<i>“Risk is an uncertain event or condition that, if it occurs, has an effect on at least one project objective... A risk may have on or more causes and, if it occurs, it may have one or more impacts.”</i>	<i>“Project risk has its origins in the uncertainty present in all projects.”</i>

When reviewing the different definitions, one can conclude that, as mentioned above, risk and uncertainty are often defined together. However, uncertainty could be interpreted as being connected to the “unknown”. The term uncertainty is expressed by Cleden (2009) as something intangible, whereas Al-Bahar and Crandall (1990) has simplified the term and described it as the probability of the occurrence of an event. Based on the definitions provided by the authors, risk is something that derive from uncertainty (Cleden 2009; Al-Bahar and Crandall 1990; Cooper et al. 2005; Klemetti 2006; PMI 2008). Some authors describe risk as the actual outcome, it is the result of an unexpected event. But in contrast to uncertainty, risk is something that are more tangible, and therefore one should be able to discover it easier.

In addition to the table above, Al-Bahar and Crandall (1990) and Chapman (1997) also mentions the importance of having the correct approach to risk when working with it. Commonly, risk is only associated with something negative that may impact their project, but Al-Bahar and Crandall (1990), Chapman (1997) and PMI (2013) also emphasizes that risks may not only be negative, but a risk can also be seen as something positive and therefore an opportunity.

Al-Bahar and Crandall (1990) have also presented a mathematical function relating the two terms: “ $Risk = f(Uncertainty\ of\ event, Potential\ loss/gain\ from\ event)$ ”. The function itself does not explain how risk is calculated but rather that risk is dependent on the uncertainty and potential loss/gain of an event.

2.3 Prescriptive risk management processes

When studying Risk Management Processes (RMPs), Al-Bahar and Crandall (1990) mention that it often relies upon the experience and judgement of those responsible of performing the RMP. This correspond with the statement that Chapman (1997) underline, that risk management processes is essentially a refined structure of common sense. These new processes do not contribute to a whole new way of thinking; they have already been used by project managers for a long time. However, Hillson (2003) describes how guidelines and certain techniques has been developed in order to help the RMP from only relying on past experience.

In the following section, a short introduction of each RMP will be presented and followed by an analysis of how they relate to one another. Three RMPs were chosen in order to give a perspective on how an RMP is described in general, similarities and differences were sought. In the upcoming chapter, Chapter 3, this information will be used to compare the prescriptive RMPs to Veidekke’s RMP.

2.3.1 Project Management Body of Knowledge (PMBOK)

The RMP was created by the Project Management Institute (PMI) and published in “*A guide to the project management body of knowledge*” (PMBOK). PMI (2013) has developed the RMP in order to handle different events, either to increase the probability for a positive event to occur, or to minimize the chances of a negative event to occur. The process is divided into five steps:

1. Plan risk management
2. Identify risk
3. Risk analysing
4. Plan risk response
5. Monitoring and control

PMI (2013) claims that all these steps will be handled at least one time each during the total lifetime of a project, depending on how the project is established. The RMP that PMI (2013) has presented, is performed in an organized and structured way, with clear start and finish of each step. However, PMI (2013) argues that all the steps may be overlapping and therefore could be handled simultaneously to some degree.

2.3.2 Construction Risk Management System (CRMS)

The second RMP is CRMS, "*Construction Risk Management System*". Al-Bahar and Crandall (1990) introduced a risk management system for contractors to use in order to analyse and manage risks in projects. The intention with this system is to structure the risk management process in order to work with risks in a systematic process, without relying on contractor's experience and judgement. They claim their risk model to provide a "*formal, logical, and systematic tool that helps contractors in identifying, analysing, and managing risk in a construction project*" (Al-Bahar and Crandall, 1990, pp 533). CRMS method by Al-Bahar and Crandall (1990) includes four processes:

1. Risk identification,
2. Risk analysis and evaluation,
3. Response management
4. System administration.

Their system has according to Al-Bahar and Crandall (1990) several features such as that "*it has an orderly and consistent way of treating complex project risks*", "*the method is objective rather than intuitive*", "*the results can be verified and documented*", and lastly "*risk managed systematically is subject to analysis and evaluation*" (Al-Bahar and Crandall, 1990, pp 535).

2.3.3 The Project Risk Analysis and Management (PRAM)

The last reviewed RMP is created by the "*Association for project management*", and referred to as "*PRAM*", abbreviation for "*The Project Risk Analysis and Management*". PRAM was developed through research on experienced organisations working with RMPs in a successful way for several years.

Chapman (1997) states that PRAM with its nine steps is more detailed than other RMPs. The PRAM model is a start-to-start precedence sequence, meaning that when the RMP starts, all steps run in parallel as seen in Figure 1. The activities in many steps come in "bursts" (more intensified work on that specific subject), given an iterative process of handlings risks. These "bursts" are repeated in cycles during the whole project. The only step that is not part of the cycles is the "manage" part, which instead will be performed and started at the project execution.

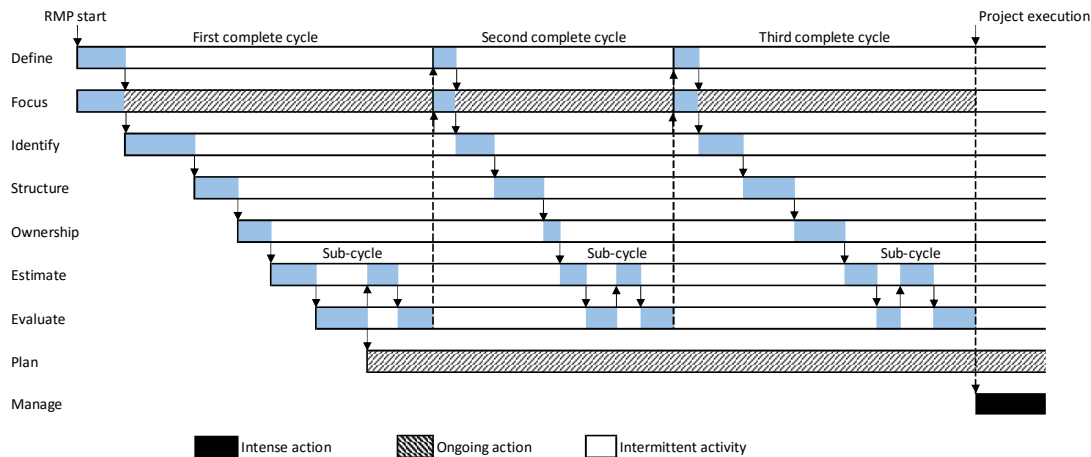


Figure 1: Chapman's RMP PRAM seen over time. The steps run in parallel, with bursts of activities in the different cycles (Chapman, 1997).

2.4 Connecting the prescriptive RMPs into mutual phases

The different risk management processes are in some ways very similar, and in some cases only differ in the terms used to describe a certain phase or step. In order to easily grasp how the different RMPs are connected, a model was created to divide the RMP steps into phases where the same output is supposed to be generated. As can be seen in Figure 2, all RMPs can be divided into a total of six phases but separately, the RMPs stretches from four to nine steps.



Figure 2: Visualization of the steps in each RMP divided into mutual phases.

In the upcoming chapters, all RMPs will be investigated and presented simultaneously for each phase, phase 0 to phase 5.

2.4.1 Phase 0 - Defining the risk management process

Phase 0, "Define", is only explained as a phase in PRAM. However, one can find this in PMBOK as input, and is explained to be work that should already have been completed before starting the RMP.

PRAM

Phase 0 can be seen as a pre-phase to the RMP, where they call it “Define”. During this phase, the intentions are to define important information for a specific project. This could for example include the aim, objective, scope, time frame, strategy, grasp an accurate understanding of what the stakeholders’ interest is, and also making sure that all areas are covered by management (Chapman, 1997).

The purpose of the defining phase is to produce documents that will act as a foundation, and as Chapman (1997, pp 274) state, “*clarify all relevant key aspects of the project which the RMP addresses*”. In order to provide the relevant information, Chapman (1997) has listed several parts that need to be tackled. These parts include e.g. collections of relevant existing knowledge, ensuring that all parties agree on the information and the status quo, and if necessary pinpoint/create new information that need to be established.

Chapman (1997) argues that it may be hard to perform and finish the define phase before continuing to the next phase, since there is always information that are not yet at hand. However, Chapman (1997) stresses the importance of being as accurate as possible in the define phases since this will influence the following work effectiveness.

PMBOK

PMBOK also mention this phase but instead of including it in their RMP, it is mentioned as “needed input” to perform the RMP (PMI, 2013). The “inputs” mentioned in PMBOK show similarity to the relevant key aspects mentioned by PRAM, the following inputs are mentioned as needed in PMBOK:

- Project scope statement
- Cost management plan
- Schedule management plan
- Communications management plan
- Enterprise environmental factors
- Organizational process assets

The main focus is however the same for both PMBOK and PRAM, they both strive for getting an understanding of the project before starting the RMP. Hence, the phase should be performed at an early stage.

2.4.2 Phase 1 - Planning the risk management process

Phase 1, the Plan phase, is only brought up in PMBOK and PRAM. The aim of the plan phase for both RMPs is to provide an understanding of what work that is needed to be completed in the RMP, and how the process will proceed. This part also gives a good opportunity to establish the procedure of how to transfer knowledge between the cycles in the project, and to inform the participants of specific periods that are extra crucial to be a part of.

PMBOK

The purpose of the plan phase, as it is called in PMBOK, is to establish a basis for the upcoming risk management activities (PMI, 2013). PMI (2013) argues that a properly performed planning phase will enhance the possibilities of good outcomes in the upcoming phases.

With the inputs mentioned in phase 0, meetings are held with personnel who have responsibilities within the risk management planning, this could for example be project managers, stakeholders and project team members.

Ultimately, the meetings should give a risk management plan defining:

- **Methodology** - approaches, tools and data sources.
- **Roles and responsibilities** - ownership and who is liable for what.
- **Budgeting** - budget and estimated resources needed for the risk management task.
- **Timing** - time frame.
- **Risk categories** - structure of the risk identification process.
- **Definitions of risk probability and impact** - Defining the different levels of probabilities and consequences, example low, medium, high.
- **Report formats** - How the RMP is to be documented and communicated throughout the project.
- **Tracking system** - How the RMP will be tracked during the single project, as well as how the knowledge will be transferred to future projects.

PRAM

In the PRAM RMP, this phase is denoted as the “focus” phase. The purpose is to deliver one or multiple documents containing information about the scope and the plan for the RMP. With the completed document established in this phase, all relevant stakeholders will be provided with the important key characteristics, making the perception of the RMP clear and unambiguous (Chapman, 1997).

The scope will answer questions e.g. why is the RMP undertaken? Who is the recipient of the analysis? What will the scope of the risk analysis be? Whereas the plan process will counter questions e.g. resource allocation, timeframes, methods and a plan for how the RMP should be completed.

As mentioned in the introduction of PRAM and as can be seen in Figure 1, the focus phase will start simultaneously as the define phase but then carried on during the five upcoming phases, making it possible to continually improve the framework and understanding. As the define phase is continually improved, it will lay the foundation for the upcoming cycles that will be performed.

2.4.3 Phase 2 - Identifying the risks

At phase 2, all RMPs are under progress and have initiated their risk management work. In this phase, focus will be emphasized on understanding the risk and pin down the underlying root cause of the risk. PMI (2013) aim to identify the risks that may take place during the project and to understand and document the different aspects of them. Furthermore, being the first of Al-Bahar and Crandall (1990) proposed steps, risk identification lays the base to the following work to be done in the other processes. If

possible risks are not identified accordingly, risk analysis and risk management becomes insignificant. Al-Bahar and Crandall (1990, pp 535) chooses to define risk identification as *“the process of systematically and continuously identifying, categorizing, and assessing the initial significance of risk associated with a construction project”*.

Identification could be done with the help of different tools or techniques and in both PMBOK and PRAM, brainstorming is brought up as one tool. Other tools include using SWOT analysis, expert judgement, or interviews. These interviews could be with experienced people within the specific area, or with an experienced project manager. These could then identify risks for the specific project based on the available project information and their own experience. All three RMPs in some way bring up a risk register that should be the final objective of the goal, though they name it differently such as “structure register”, “preliminary checklist”, or simply “risk register”. PMBOK and PRAM both bring up the potential adding of responses already in the identification phase, while CRMS goes into defining the consequences of each individual risk.

PMBOK

The gathered result will be composed in a “risk register”, which will be used and updated throughout the following phases. This risk register will foremost contain a list of identified risk with a structure describing the possible event which may occur, along with an impact that may arise due to the identified risk. PMI (2013) claims it is crucial to keep the format of the documentation similar between the risks in order to benchmark them against each other.

PMI (2013) also introduces the possibility to add potential responses already during this phase. This activity is not directly connected to the identification phase but may give valuable inputs for future phases. Later in phase 4, a complete response plan will be conducted.

PRAM

This phase, called “Identify” in PRAM, is divided into two parts; search and classify. During the “search” part, methods like interviewing, brainstorming and checklist are used which then transcend to the “classify” part where the risks are organized and structured, making it easy to define the risks and responses (Chapman, 1997).

Ultimately, the identify phase will provide a structure register containing all the risks and responses. Chapman (1997) argues that it is important to classify the risks with a response, even if it sometimes only will be a preliminary response, which even could be in the form of “do nothing and accepts the risk”. Moreover, Chapman (1997) claims the risk assessment should not only include negative outcomes but also opportunities.

CRMS

Being the first of Al-Bahar and Crandall (1990) proposed steps, risk identification lays the base to the following work to be done in the other processes. It is empathized that the risk identification process must contain an investigation of all risk that may or may not occur. Al-Bahar and Crandall (1990, pp 535) chooses to define risk identification as *“the process of systematically and continuously identifying, categorizing, and assessing the initial significance of risk associated with a construction project”*. In the

risk identification process, Al-Bahar and Crandall (1990) divide it into six different steps as shown in *Figure 3*.

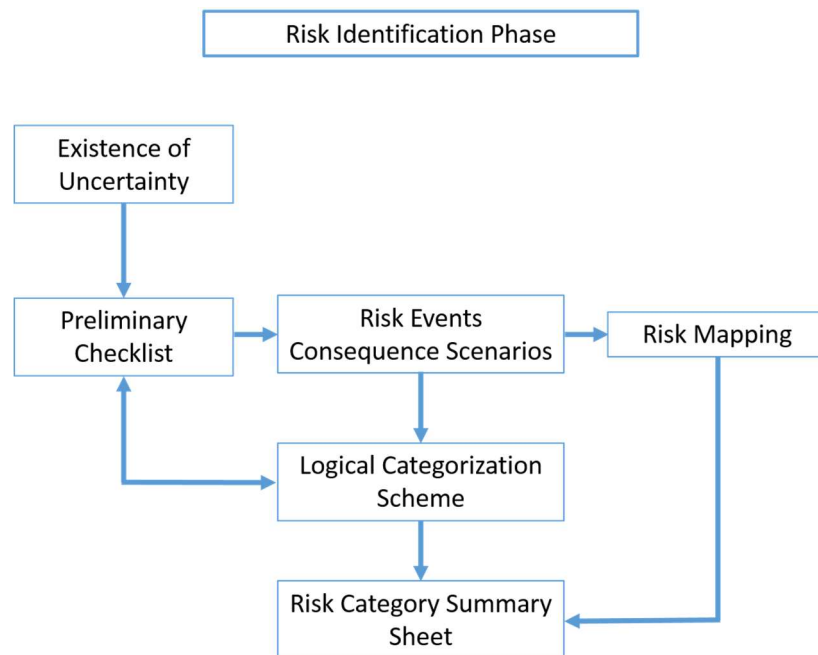


Figure 3: The six steps included in Al-Bahar and Crandall (1990) risk identification process.

Preliminary checklist

The first step in the risk identification phase is the preliminary checklist. This checklist should include the risk that is identified for the specific project. However, if a risk would not be identified in the preliminary checklist, it is stated that it could lead to disaster, or if a positive risk leading to not gaining what could be gained from a risk. This further emphasizes the importance of the risk identification step.

The checklist could be performed in several different ways, though Al-Bahar and Crandall (1990) explains the importance of not relying on past experience, they mention past experience as merely one of the ways to identify risk in the checklist – which surely is inevitable. Other ways of producing a checklist of risks could be by using commercial checklists or survey questionnaires.

Identify Risk Events/Consequence Scenarios

Identifying risk event or consequence scenarios is the second step of the risk identification. This could for instance be what kind of economic gain or possible loss a certain risk would offer, if a risk could involve injury to a person, damage to the construction, or if the risk would be affecting the time schedule of the project. According to Al-Bahar and Crandall (1990), most risks in the construction sector is considered to be financially related, and therefore they claim that the emphasis on the consequence which could occur from a risk should be related to the financial aspect of a consequence.

Risk mapping

In risk mapping, an Iso-curve is used in order to identify the most critical risks in regard to probability and potential severity, see Figure 4. Since a risk for Al-Bahar and Crandall (1990) is defined as a function of probability and severity, the risk can be of the same size if changing these inputs, giving the Iso-Risk Curves. The Iso-curve being the furthest away from the origin represents the greatest risk. The risk mapping process will enable a simple graphical illustration for the project manager of which risks that might need more consideration than others.

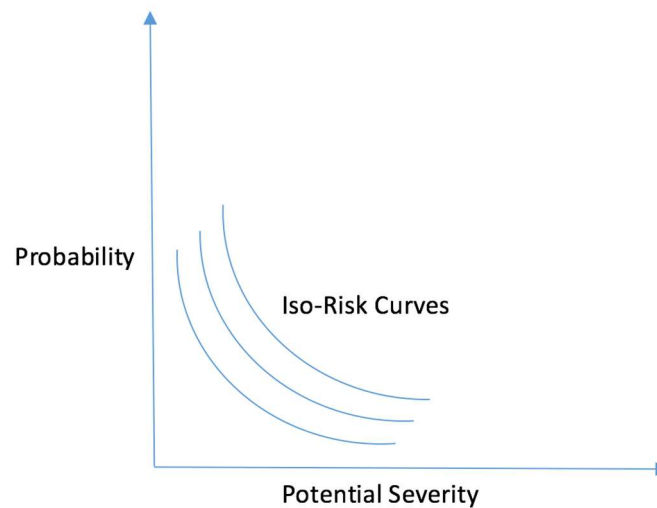


Figure 4: Risk mapping considering probability and potential severity according to Al-Bahar and Crandall (1990), plotted in an Iso-curve graph.

Risk classification

In Al-Bahar and Crandall (1990), risk classification is based on the nature and the potential consequence of the risk associated with the category. There are six categories and these are, according to the authors, showing the diversity of risks and giving a full overview of all the risks, in order for the one examining the risk to not focus on just one type of category. One of the risk categories in Al-Bahar and Crandall (1990) is for example “Acts of God”, with typical risk for this category would include flood, earthquake, landslide, fire, wind, and lightning, see Table 2 for full overview.

Table 2: The risk categories and the typical risks regarding each category according to Al-Bahar and Crandall (1990).

Risk category	Typical risks
Acts of God	Flood, earthquake, landslide, fire, wind, lightning
Physical	Damage to structure, damage to equipment, labour injuries, material and equipment fire or theft
Financial and economic	Inflation, availability of funds from client, exchange rate fluctuation, financial default of subcontractor, non-convertibility
Political and environmental	Changes in laws and regulations, war and civil disorder, requirements for permits and their approval, pollution and safety rules, expropriation, embargoes
Design	Incomplete design scope, defective design, errors and omissions, inadequate specifications, different site condition
Construction-related	Weather delays, labour disputes and strikes, labour productivity, different site conditions, defective work, design changes, equipment failures.

Risk category summary sheet

The final step in Al-Bahar and Crandall (1990) risk identification process is the risk category summary sheet. In the summary sheet all the participants work in the risk identification process is summarized in a chart, so that no risk is delegated to a certain person but instead the team. In the summary sheet all risk events, the description of the risk event, and the conditional risk variables are clarified.

2.4.4 Phase 3 - Analysing risks

The third phase represent the analysis phase. Here, the different RMPs choses different ways of presenting the phase, but similarities can be found. All three RMPs states the importance of prioritizing the identified risks in order to see which risks needing more work than others. PRAM emphasizes that the goal is to understand the underlying relationship between the identified risks and its consequences, while PMBOK states the aim is merely to analyse the risks and prioritizing them. All three RMPs also presents different techniques on how to analyse the risks in depth, one of the methods presented in all RMPs is the probability and impact/consequence analyses. PRAM also choses to look into ownership of each risk, something not being discussed for CRMS and PMBOK, but instead it is mentioned in the next phase which deals with response.

PMBOK

This phase is divided into a two-step process. Each step will describe a technique on how to analyse the risks from the identification phase. The two processes are qualitative risk analysis and quantitative risk analysis.

Qualitative risk analysis

The general qualitative analysis emphasizes on the words and expression rather than analysis of numbers (Bryman & Bell, 2005). Since the method focuses on verbal expressions, interviews and other types of meetings are often performed. Moreover, Bryman and Bell (2005) explains that the theory is established by collecting the interpretation of a selection of people where conclusions has been drawn in an inductive manner (empirical experiences). PMI (2013) has presented a couple of techniques to perform the analysis:

- Risk probability and impact assessment and prioritization using probability and impact matrix
- Risk data quality assessment
- Risk categorization
- Expert judgement

The aim of this step is to analyse and prioritize the risks from the identification phase. The qualitative analysis of the risks will ultimately add information to the risk register where the following can be found; priority list, risks grouped by categories, causes of risk, list of risks requiring responses in the near-term, list of risks for additional analysis and response, watch list of low-priority risks, trends in qualitative risk analysis results.

Quantitative risk analysis

The second step in the analysis process is the quantitative risk analysis which is a continuation on the qualitative analysis. The risks prioritized in the qualitative analyse will now be managed and analysed in depth. The quantitative risk analysis is a structured and organized process (Bryman & Bell, 2005) which focus on the numbers related to the risks (PMI, 2013). These numbers can be collected via different techniques, e.g. interviews and/or numbers used in previous projects, which then can be used in tools e.g.:

- Sensitivity analysis - which determine how great impact the risk can affect
- Expected monetary value analysis - which present potential cost outcomes of a risk
- Modelling and simulation
- Expert judgement

The outputs of the analysis are concluded in the risk register used in PMBOK's process, which was brought up in Section 2.4.3, adding information regarding; probabilistic analysis, probability of achieving cost and time objectives, risk prioritization and risk trends.

PRAM

Pram chooses to divide its analysis phase into four different steps being structure, ownership, estimate, and evaluate. Even though Chapman (1997) has divided this phase into four steps to make the process structured, actions are still started in one step but finished in a later one, e.g. prioritization of risk which is started in the structure step and finished in the evaluation step.

The aim of PRAM's analyse phase is to first structure the identified risks, finding connections to other risks and making a list of prioritization. Later, ownership is discussed and it is determined who should be the responsible party for each risk. Estimation is then made, using numbers or labels to represent uncertainty, probability and impact. Lastly, the risks are evaluated and challenged, finding certain problems or issues for a specific risk's plan of action.

Structure (step 1 of analysis)

The purpose of the structure phase is to make it easier to understand what one should focus more or less on. Some risks can be simplified while other need extra assessment. The motive of this step is to make the risk management more efficient, and thereby reducing the likelihood of missing out on risk responses and opportunities. Chapman (1997) therefore claims it is important to keep the structure simple. The structure phase includes three tasks, 1) Refine classifications, 2) Explore interactions, and 3) Develop orderings.

1. Due to new insight of the earlier developed risks and responses, there may be reason to change existing classification, e.g. the risk may not play out as big a threat as assumed, or vice versa.
2. Connections are sought between different risks in order to find a common denominator. If a link is found, one should try to understand this link and why it exists.
3. A prioritization list is constructed consisting of the defined risks. It should also include a list of responses to the risks were the consequences are included.

The goal of the structure step is to understand the relationship between certain risks and the implications of those.

Ownership (step 2 of analysis)

The purpose of this step is according to Chapman (1997) threefold. Firstly, the risks that one wants someone else to have responsibility for, but still is prepared to manage by himself/herself, is presented. Secondly, the individuals being responsible for managing the risks and responses is to be chosen. Thirdly, it includes the allocation of ownership and/or management put on third parties. The results from the ownership phase should give the understanding of which risks that are allocated to whom, and to know who is legally enforceable if so needed.

Estimate (step 3 of analysis)

The estimation part in this phase regards cost, time, and, if needed, other measures of performance. This phase should further have two purposes, the first being to identify those areas in the project that "may" include a higher degree of uncertainty, and therefore need increased attention of data acquisition and analysis. The second purpose is similar, instead it is not a question of "may" but to identify those areas in the project

which “*clearly*” include a higher degree of uncertainty, and therefore require decisions and judgement calls that are carefully elaborated. This distinction between the two purposes of “*may*” and “*clearly*” is important in order to use time and resources on those risks which poses a greater damage to the project than on risks with a lower uncertainty or with clear and simple response actions.

From the estimation, the probability and consequences of the risks should be conducted in terms of cost, duration, or other criteria’s (Chapman, 1997). Further, Chapman explains that many methods within RMP suggest to present the data numerically. Other chooses to use labels like High, Medium, or Low, and in some cases both are used where the labels are used first and numeric data is used later. However, it is also stated that some believes that the use of labels is merely a loss of time, and therefore numerical presentation should be strived for. When completing the estimation phase, one should understand the risk responses and which risks being of more importance than others.

Evaluate (step 4 of analysis)

The evaluation phase has the purpose of evaluating the results from the estimation phase (Chapman, 1997). Firstly, the evaluation phase should give a prioritization list of all the identified risks, and later on may deliver certain problems or issues for a specific risk’s plan of action, and if so also suggestions to how to resolve this issue.

CRMS

When the risks have been identified, Al-Bahar and Crandall (1990) continues with the analysis and evaluation process of the identified risks. From the identification phase, the project team will see some risks being more significant than others and therefore concluding that those risks need further analysis. This analysis and evaluation is said to form the base for the next step considering response management. Al-Bahar and Crandall (1990, pp 539) chooses to define this phase as “*A process which incorporates uncertainty in a quantitative manner, using probability theory, to evaluate the potential impact of risk*”.

The risk analysis and evaluation phase is divided into several steps, data collection, modelling uncertainty, and evaluation of potential impact of risk. The scheme of how the steps are processed is described in Figure 5.

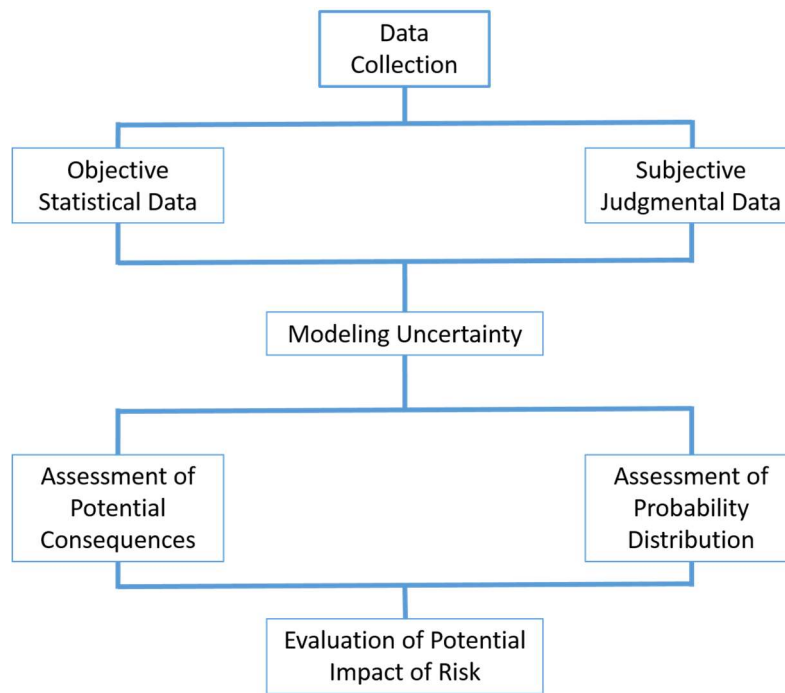


Figure 5: The different steps in the risk analysis and evaluation process according to Al-Bahar and Crandall (1990).

Data collection

Data collection could come from the contractor's experience in previous projects but in many cases the data collection will need a subjective assessment. According to Al-Bahar and Crandall (1990), contractors working at the construction site rarely document the data needed in order to make this data collection for further projects. Hence, Al-Bahar and Crandall suggest that person(s) or expert(s) with the relevant knowledge of the proposed risk should be questioned for the data collection.

Modelling Uncertainty

When modelling uncertainty, likelihood of a risk and its potential consequence is used in order to present a number, or a size, of a single risk. The likelihood of the certain risk is considered to be the probability of the risk occurring, while the consequence should be expressed in monetary terms.

Evaluation of Potential Impact of Risk

When each single risk has been modelled, the final step in the analysis and evaluation process of CRMS is to assess the complete effect of the risks identified and modelled in the project. Al-Bahar and Crandall (1990) explains that during this evaluation most analysts use the expected value theory, meaning that the uncertainty of a risk is multiplied by the expected loss, or gain, of a certain risk. This is done for each risk and a sum is later concluded, showing the total risk, expressed in monetary terms, of a certain project.

2.4.5 Phase 4 - Planning the risk responses

The different RMPs chooses to discuss the response phase differently. PMBOK claims that the purpose is to strengthen the possibilities of opportunities, and minimizing the likelihood of the negative risks to occur. PRAM instead claim that the aim is to provide a project plan, which should be ready to be utilized when needed. PRAM could

therefore be seen to be accepting the risks and does not try to change the probabilities, but instead to tackle them as they are. CRMS take a similar approach as PMBOK, but underlining that the purpose should be to decrease potential impact of risk, and not decreasing probabilities as in PMBOK, and further to increase control of each risk. Also, both PMBOK and CRMS presents risk responses in order to tackle each risk, the only difference being how acceptance is discussed and that CRMS presents an additional response, being insurance. However, between the three RMPs, only PMBOK presents response techniques connected to opportunities. This does not correspond with the focus that all the RMPs mediate in their introductions. It is mentioned how important the management of negative risks is, and that it is often forgotten about the opportunities that are given. Still, neither CRMS nor PRAM present any responses connected to opportunities. Finally, ownership of risks was not discussed in phase 3 for PMBOK and PRAM, but is instead present in this phase.

PMBOK

PMBOK's purpose of the response phase is to go through the risks and strengthen the possibility of an opportunity to occur and to minimize the probability of a risk. With the output of the previous phase, e.g. updated risk register and "prioritized list of quantified risks", it is now time to assign responsibilities to "risk response owners" in order to handle and plan counter actions for the risks and opportunities. The aim is to go through the risks and opportunities, orderly and then select the appropriate response. PMI (2013) argues that there is a need to have different responses to choose between since responses meet project requirement differently, e.g. some affect the budget and other the time.

PMI (2013) present four techniques to manage negative impacts and four techniques on how to manage opportunities. Negative impacts are handled via either avoidance, transfer to a third party, mitigation or acceptance. Whereas the positive risks and opportunities are managed via exploiting, sharing, enhancing, or accepting.

Depending on which actions the project team use, risk responses will have different outcomes. However, the concerning documents that might be updated in this phase are the "risk register", "project management plan", "project documents" and "risk-related contracts".

PRAM

The aim is to give a project base plan, with plan of actions, which is ready to be utilized by the project team (Chapman, 1997). This phase includes the work of verifying that each plan of action for the risks is completed and worked out in detail. These plans are the deliverables of this phase.

Chapman (1997) further explains that the details of the plan of actions should be delivered. Information such as timing, ownership, contractual terms, and the potential need of using resources should be brought forward.

The project base plans may not always be enough since things might not go as planned, and Chapman (1997) therefore present the need of developing contingency plans as well. The contingency plans should present the relevant detail information for the base plans, with timing, ownership, contractual terms, and the potential need of using

resources. Trigger points for when the contingency plans are implemented should also be presented.

CRMS

Prior to this phase, risks have already been identified and quantified in terms of probability and monetary terms. During the response management process, different strategies are chosen in order to handle these risks – depending on the size and/or probability of the risk. Response management has, according to the authors, two important parts: the first being that it is used to decrease the potential impact of the risks, and secondly to increase the control of each risk.

Al-Bahar and Crandall (1990) states that when managing risks there are two approaches that could be used. The first approach is where the project manager/team, or the one(s) responsible for managing risks, tries to reduce the probability of a certain risk of occurring, or if possible to reduce the impact of a negative risk - called risk control. The different strategies for risk control is risk avoidance, loss reduction and risk prevention, retention (assumptions done by the entity), transfer, and lastly insurance. These strategies are further explained in Section 2.4.5.1. Using the second approach, one is not trying to reduce the impact or probability of the risk, but the organization determines how a potential risk can be financed if it would occur – called risk finance.

2.4.5.1 Risk response techniques

The following chapter describe different response techniques presented by PMBOK (PMI, 2013) and CRMS (Al-Bahar & Crandall, 1990). CRMS only focus on responses in regards to negative happenings, while PMBOK discuss both negative and positive events.

Negative risk responses

The following risk responses are those responses dealing with negative risks.

Risk avoidance (PMBOK & CRMS)

PMI (2013) clarify that risks are avoided by changing the project management plan. This include changes in the scope and the objective of the project. Worst case scenario would be to terminate the project totally. In a similar way, CRMS describes it as a technique to avoid the risk so that it does not occur. An example is when a contractor has the potential risk of encountering asbestos material in the ground. This risk could be avoided by never taking any projects which involves the contractor doing the groundwork of a given project (Al-Bahar & Crandall, 1990).

Risk transfer (PMBOK & CRMS)

Transferring is not about handling the risk, minimize it, or eliminate it, but rather shifting the responsibility to another party. PMI (2013) claim that these types of risk transfers are common within financial areas, and does mostly include some sort of risk premium that the risk transferor must pay in order to move the risk away from them. These requirements are ultimately clarified in a contract. CRMS claim that this is managed via contractual terms and the risk could be transferred to, for example, the owner, subcontractors, or a supplier of example material or equipment.

Mitigation, loss reduction and risk prevention (PMBOK & CRMS)

Mitigation of risk refers to reduction of the likelihood of a risk to occur and to reduce the financial effect of which the risk would attain (PMI 2013; Al-Bahar & Crandall 1990). PMI (2013) state that it is more cost efficient to take care of a risk early in the project rather than spending money fixing the outcome of a risk. Examples of risk mitigation could be to “*adopting less complex processes, conducting more tests, or choosing a more stable supplier*” (PMI, 2013, pp 304). Other examples which Al-Bahar and Crandall (1990) presents is if a contractor wishes to reduce the risk of machines and/or equipment to be stolen, the contractor could install an anti-theft system.

Risk acceptance and retention (PMBOK & CRMS)

By accepting a risk, the project team has decided to not take any specific responses to handle the risk (PMI, 2013). However, acceptance can be handle in either a passive or active way. By conducting a passive acceptance technique, the project team has decided to not change the project management plan and only handle the consequences as they occur. While active acceptance still accepts the risk, it also includes a “contingency reserve” which is supposed to fund the outcome of the risk costly and timely. Similar, Al-Bahar and Crandall (1990) state that it could either be planned or unplanned and it is more or less what the entity believes, or assumes, the financial impact to be.

Risk insurance (CRMS)

Al-Bahar and Crandall (1990) claims the risk insurance technique is fairly common. An insurance policy is bought in order to make sure that even if a potential risk occurs it will not affect the project or company (Al-Bahar & Crandall, 1990).

Positive risk responses

The following risk responses are those responses dealing with positive risks, of the studied RMPs they are explained in PMI (2013).

Exploit

Exploiting of opportunities include changes in the project management plan to gain the consequences of an opportunity (PMI, 2013).

Share

Related to transfer, sharing opportunities is about assigning the task of realizing the opportunity to a third party that has the best chances to fulfil them. By including a third party, more stakeholders get the possibility to gain something which makes it more possible to happen (PMI, 2013).

Enhance

Putting more effort into “key drivers” that ultimately increase the possibility for the opportunity to occur (PMI, 2013).

Accept

Similar to the acceptance of the negative risk, positive risk acceptance does not emphasise on putting resources on the possibility to collect the opportunity but rather “hope” to get it (PMI, 2013). ‘

2.4.6 Phase 5 - Monitor, control, and manage the risks

This final phase is about managing risks and how to control them. Several ways to monitor the risks are presented, the RMPs discusses the need to control the performance of the responses and to find deviations from the risk management plans. PMBOK and CRMS stresses the need of storing data while PRAM brings up the need of continuing the work and develop more detailed plans if needed and to see which risks that may need more attention than others. CRMS also brings up the importance of evaluating the whole process, in order to improve the work for the next project.

PMBOK

This phase will last during the whole execution of the project. The aim is to monitor and control the performance of the responses developed in the previous phase but also to continue and maintain the work of identifying new risks. PMI (2013, pp 308) further claims that the phase aims to determine if:

- “Project assumptions are still valid”
- “Analysis shows an assessed risk has changed or can be retired”
- “Risk management policies and procedures are being followed”
- “Contingency reserves of cost or schedule should be modified in alignment with the current risk assessment”

Moreover, PMI (2013) underline that monitor and control is also about looking at which alternative strategies that can be used, coming up with contingency plans, and looking at the project management plan in order to correct it in those areas it is necessary. This is performed via tools such as risk reassessment, risk audits, technical performance measurement, and status meetings.

PMI (2013) also states that the communication between project executors and the project manager must be well established to be able to get the correct perception of the project performance regarding the risk response.

Finally, the risk and responses should also be collected and stored in a database where the information from the current and previous projects can be found and overlooked, to strengthen the future work of risk management.

PRAM

Monitor and control is referred to as “The manage phase” in PRAM. This phase is included in the production process of the project. In the manage phase, monitoring of the risks is required to find deviations from the risk management plans brought forward from the previous phases. According to Chapman (1997), the managing phase intend to develop more detailed plans if necessary, and to review the plans and re-plan if so needed. Furthermore, a risk-response list should be conducted on a regular basis as well as detailed reports to provide information of which risks that may need more attention than others. If a certain event deviates from the plan or what was thought to be believed, re-planning and reports regarding this change should be conducted.

CRMS

Monitor and control is referred to as “System administration” in CRMS. The work that were completed in the previous steps shall now be administered, monitored, and reviewed. Each business or entity have their own administration process or procedures regarding risks. Al-Bahar and Crandall (1990) emphasizes that there are more and more contractors who sees the need of establishing a more formal risk management function. In order to do so, policies, procedures, goals, and allocation of the responsibility of the risk must be set.

Records and reports is also an important part of the system administration, including storing data in a correct and logical way. The records and data functions of the entity also enables statistics to be shown which could help in decision-making when choosing the plan of action for a certain risk. Data that could be collected is for instance how often the risk occurs, the magnitude and severity of the risk, and what the consequences of a certain risk showed to be.

The final step in the system administration phase is the evaluation of the CRMS process. This should be done in order to improve the work done for a single project to learn to the next project. Further development is needed since each project is unique and the environment in which the sector operates within is always changing. The risk management program “is not static but must be dynamic and ongoing”. Each risk’s severity or probability may change over the years or for the type of projects of which the business chooses to take on, meaning that the risk management process will change accordingly.

2.4.7 Summarising the prescriptive risk management processes

At a first glance, the three RMPs look quite different. All RMPs are divided into steps and processes differently, and giving each phase a slightly different name. However, after the comparison was completed, one could understand that the RMPs had much in common. Based on Al-Bahar and Crandall (1990, pp 535) statement regarding that CRMS was created via a development of an already existing RMP, this may not be so surprising.

“With respect to this paper, we will improve and modify the conceptual model proposed by Wideman, and convert it into a completely defined management model of risks in construction projects.”

One can get the sense that many of the RMPs that are valid today, may have the same origin but have been modified and therefore making them different. Also, it is interesting that the CRMS model, which is created to the aspects of the construction industry, has a lot in common with both the PMBOK model and the PRAM model which both are general.

The study of the different RMPs has shown that all processes, being general or for a specific branch, divide its process into the different phases of plan, identify, analyse, respond, and lastly monitor and control. The planning phase, being before the identify part, is seen in two of the three studied processes. It is simply a way for the risk management group to structure and plan the work that the risk management will need.

2.5 Human aspects

The RMP in an organization will not only depend on the framework, but also on the individuals performing the work. Different persons and different groups behave differently, approaches risks differently, and take decisions in different ways. This puts focus on human aspects and its potential to influence the processes.

Smith et al. (2006) claims that people think it is inconvenient to argue for an investment, in order to avoid a risk that *may* occur in the future. People are said to be reluctant to invest in issues that will not guarantee them a return. Furthermore, Smith et al. (2006) emphasise that the interaction between managers and stakeholders, about how the risk management work is carried out, is greatly affected by the understanding of the human aspect, along with the motivational, the attitude, and the cultural matters.

Risk management will always be a part of people's life, whether they are at work or at home. We are constantly confronted with having to make decisions, and unconsciously we probably always make some sort of risk analysis, this could be situations like taking the next tram and jeopardize coming late to work, or investing in a certain building (Smith et al., 2006). However, in some scenarios we are confronting risks and uncertainties without making "rational" decisions, since it excites people, like parachuting out of a plane or base-jumping. People are also said to perceive risk in different ways, either they are risk averse or risk takers (Smith et al., 2016). It is therefore important to establish a risk management team containing all sorts of people that together complement each other and make the right risk assessments.

Kerr and Tindale (2003) claims that decision making in groups is about going from a stage where the group has a separate vision and unshared perceptions of a subject, which then proceeds to a stage where the group has formed consensus. However, groups have different qualifications which will influence their work. In the following sections different aspects of group influences will be presented, as well as a theory of how people value gains and losses.

2.5.1 Group influences of shared cognitions

Group decision and performance is influenced by many factor, such as the perception of mutual cognition, or as Kerr and Tindale (2003) describes it, "hidden profiles". According to Kerr and Tindale (2003), the perception of having the same cognition within a group will allow that specific topic to take over discussions of other "unshared" topics. Kerr and Tindale (2003, pp 636) define previous research findings of this subject as "*groups focus on and discuss shared information at the expense of unshared information, thus leading to their failure to uncover hidden profiles*". Kerr and Tindale (2003, pp 637) have presented four statements that acknowledge hidden profile:

1. "*Shared information's is more likely to be discussed*"
2. "*The need to reach consensus in a situation where most of the members already share the same preference could lead to reduced information exchange and early consensus*"
3. "*People prefer to both receive and present information that is shared*"
4. "*Group members do not like to change their initial preferences once formed*"

However, according to Kerr and Tindale (2003), research has found that unshared information tends to be discussed more over time. Hence, there is a greater chance of the topic of unshared information to be brought up if the discussion is extended with more time. Moreover, if members of the discussion have prepared a list of topics to be discussed before the meeting, there is a greater chance of the unshared information's to be processed within the group discussion. Also, if the group meeting is divided into two parts, one "information search" part and one "integration and decision" part, the output of the meeting will be more elaborate and complete (Kerr and Tindale, 2003).

2.5.2 Groups and groupthink

A group can according to Smith et al. (2006, pp 28) be defined as "*two or more individuals who are interacting with one another in such a manner that each person influences and is influenced by every other person*". The question with may arise when considering group is whether a group will deliver a better result than the individual. Smith et al. (2006) claims that if a certain person is considered an expert and therefore knows his or her subject very well, the expert's decision will in most cases give a better accuracy than the decision performed by a group. Important though is that the decision or result from a group most often outweighs the average individual decision taken by each member of the group. In a group the knowledge base is also larger than the one of a single individual. Smith et al. (2006) concludes that the group in most cases outperforms the decision from a single individual.

Groupthink is when individuals put together in a group acts in a way to promote unity in the group (Smith et al., 2006). Groups can in some cases enhance a risky behaviour, since when acting in a group there is always someone else to put the blame on if it does not go as planned (Kowert, 2002). Smith et al. (2006, pp 29) claim that there are four main circumstances that can enhance groupthink:

1. "*Groups that are isolated from the judgements of qualified outsiders*"
2. "*Groups with a strong leader and the procedures for debate are not established*"
3. "*A lack of a methodical approach*"
4. "*Where there are immediate pressures to reach a solution*"

In order to make sure a group does not fall prey to groupthink, Smith et al. (2006) states that one should encourage group members to disagree with each other, making sure that each individual is critical to what is being discussed, and promote those members of the group who questions or even criticize a favoured plan.

2.5.3 Prospect theory

In normative theories on decision making, people are not assumed to differ in their approach depending on whether they are facing a possible gain or possible loss (Neumann and Morgenstern, 1947). However, the prospect theory claims the opposite.

The prospect theory states that people tend to look at the difference in value in comparison to the actual outcome. The difference in value of gaining \$100 compared to gaining \$200 seems to the individual to be much greater in terms of value-changing

than the difference of gaining \$1100 comparing to gaining \$1200 (Kahneman and Tversky, 1979), even though the difference and actual outcome in both cases is \$100. Following the same assumption, the difference between losing \$100 compared to \$200 seems greater than the difference in value of losing \$1100 compared to \$1200. This gives a nonlinear function when describing how risk-seeking or risk-averse individuals tend to act. The function should also according to the authors be steeper for the losses in compared to gains. This gives a function as shown in *Figure 6*.

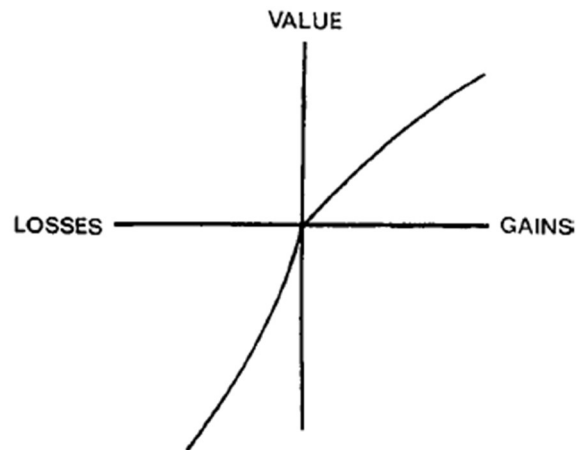


Figure 6: Kahneman and Tversky (1979) proposed model of the difference in value between losses and gains.

In

Figure 6, the reference point (origin) is mostly seen as the current wealth of the individual. So a way to look at it is imagining losing \$5 on the way to work or school, one would according to the model by Kahneman and Tversky feel over-exaggerated badly about that. The loss of \$5 very soon seem like a big change in value, see *Figure 6*. This in comparison of earning \$5 on the way to work, by example finding it on the street and picking it up, that would feel like a much less change in value to your reference point (which is your current wealth). \$5 is \$5 no matter of it being a loss or a gain, and it does not change your current wealth too much (assuming you have a stable income) but still its change in value depending on if you would lose or gain \$5 changes dramatically.

2.6 Summarizing the reviewed literature

The review of the literature has presented prescriptive RMPs that can be found in literature. It has shown that the different processes mainly vary in details and that the content is very similar. In order to analyse these prescriptive models against practice, Veidekke's operational system will in the next-coming chapter be presented and compared to the prescriptive RMPs.

The studied theories on human aspect has shown that there are much more than a systematically and well-established RMP that is needed. Besides the RMP, a team which can perform at their best need to be put together, so that e.g. groupthink and shared cognitions is avoided. The prospect theory explains how people tend to value negative outcomes greater than positive gains, even if they are of the same size. This will further be analysed in the upcoming interviews.

3 Veidekke's Risk Management

In this chapter, a review of Veidekke's operational system is made. To make the presentation of Veidekke's RMP within their operational system comprehensible, the information that is available at Veidekke's internal network will be analysed and reviewed in accordance to the prescriptive RMPs. The descriptions that will be presented is only from available texts and documents in the operational system and not a perception of Veidekke's employees' implementation, this will instead be presented in Chapter 3.3. This chapter will present several differences between Veidekke's RMP and the prescriptive ones, a summary of the findings from the interviews can be found in Appendix 2.

3.1 Describing the operational system

Veidekke's operational system is divided into five different processes, Market, Tender, Planning, Production and Warranty, called Main process, see Figure 7.

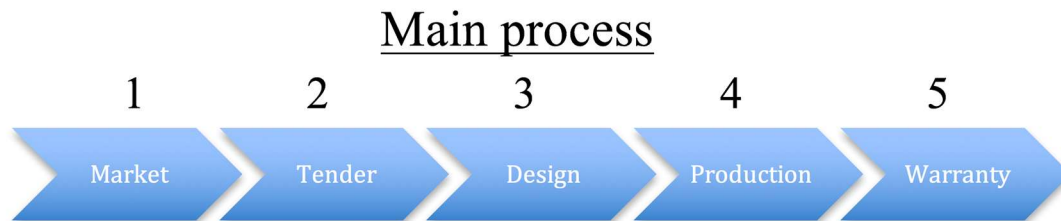


Figure 7: Visualization of the main process in Veidekke's operational system.

By entering the content in any of the different processes, a guideline/description of how to perform the work is explained, with the correct routines, procedures and documents. A project goes through each of these processes and in the process of tender, design, and production, risk management is one of many parts that need to be carried out.

3.2 Understanding the RMP at Veidekke

Veidekke's RMP states that risk and opportunity management is initiated during the tender phase and continues throughout production. Hence, risk management at Veidekke is not included in the process of marketing and warranty.

The information available in Veidekke's operational system regarding their RMP is adequate, but not described in a comprehensible way. A complete linking of information between steps and procedures is sometimes missing. To get a better overview of how Veidekke's RMP relate to the RMPs from Chapter 2, Figure 8 was created by the authors of this thesis.



Figure 8: Visualization of the steps in Veidekke's RMP compared to the prescriptive RMPs.

As can be observed in Figure 8, Veidekke has a similar setup of the phases but the transition between the phases is not as clear. Moreover, Veidekke claims that their RMP

is performed iterative, one cycle for each operation system process (tender, design and production). This means that each phase will be performed three times.

In the following sections, each phase of Veidekke's RMP will be benchmarked against the prescriptive RMPs in Chapter 2.

3.2.1 Phase 0 - Defining the risk management process

As stated in Chapter 2, it is only PRAM that includes phase 0 as a part of the RMP. PMBOK only mention the parts included in phase 0, e.g. scope, cost-, schedule-, communication- management plan, but assumes that these areas have be handled before the start of the RMP. Phase 0 is not brought up in Veidekke's RMP either, but it can be assumed that these steps are also managed before the RMP at Veidekke starts.

3.2.2 Phase 1 - Planning the risk management process

Phase 1 for the prescriptive RMPs is about gathering and process information that can generate a clear plan over the RMP. Veidekke however, has a simpler setup. Instead of presenting a suggestion of a general process of how to conduct the planning phase for any project, only general and short information about risk management definition, purpose, roles and responsibility, is presented. The part where the risk management team is supposed to go through the understandings of the RMP is therefore lacking, which is described as the main intention of this phase in the prescriptive RMPs.

Veidekke define risk and opportunities as the:

“Work tasks, constructions, installations, building parts, other external factors that are new and not known from previous experience, and/or, especially complicated; which may affect time, economy, quality, environment, and, Occupational, Health and Safety (HSE).”

In comparison to the prescriptive definitions, Veidekke's definition is not as general, but instead chose to define it using examples of concerning areas. In a way Veidekke talks about uncertainty by stating “...and not known...” in their definition, which was a crucial part in the prescriptive RMPs, but Veidekke phrase it differently.

Furthermore, Veidekke claims that the purpose of risk management is to identify, assess and handle risks and opportunities in a systematic way in order to avoid disturbance, damage and serious economic losses. This statement matches the purpose of the prescriptive RMPs to a high degree. In the same way as the prescriptive purpose is described, Veidekke describes it in a general way.

The responsibility differs depending on which process one is working with. At an early stage during the tender process, the responsibility for making the risk analysis for the tender lies with the procurement calculator. If the tender is accepted, the project moves forward to project design. In the beginning of each projects design phase, a start-up checklist is conducted. It is stated in the start-up checklist that one person is to be announced to be responsible for the risk management. For the design phase, responsibility lies with the operational manager. Lastly, for the production phase, the responsibility is held by the site manager.

Veidekke also brings up the importance of informing the staff connected to the project and those on the construction site being affected by the RMP, which is in accordance with the prescriptive RMPs.

In the prescriptive RMPs, areas such as structure of the risk identification process, report formats, and knowledge transfer is brought up as to be mentioned in this phase. However, this is not included in Veidekke's RMP, a planning phase barely exist. Instead one can find out about these areas by actually doing the RMP, since it is brought up later. One could therefore argue that the holistic perspective is missing, which the purpose of this phase is according to the prescriptive RMPs.

3.2.3 Phase 2 - Identifying the risks

The prescriptive RMPs has suggested a collection of different tools that may be useful in the identification phase. Veidekke has instead reduced the amount of tools to identify risks, they have however created two versions of a document called "Risk and Opportunities". This document could be associated to the "risk register", "structure register" or "preliminary checklist", which the prescriptive RMPs describe. Veidekke's documents will be used as an archive where information is stored and organised. The documents vary a bit depending on which process cycle one is working in; tender, design, or production. However, the way the identification part is carried out does not vary regardless of which process cycle one is working in.

Veidekke has not implemented a substantial guide on how to systematically discover potential risks. Veidekke has merely explained that in order to identify new risks and opportunities, experience from earlier projects are used. Veidekke underline that help can also be received from risk assessments done by the client, hired subcontractors, or suppliers. These techniques are also mentioned in the prescriptive RMPs, but Veidekke is lacking the more substantial tools to identify risks.

Following is two sections where the identification process is described depending on which process cycle one is working with.

Risk and Opportunities – Tender

The document connected to the tender phase contain two choices of methods to perform the identification. One method is simplified and include a general bullet list (see the red box in Figure 9), with possible risk and opportunities that Veidekke's RMP argues is common within the different processes. The template document is not designed with open slots where new risk and opportunities could be put in, but it is possible to add new rows where new information could be registered.

The document regarding “Client and Economy”, see Figure 11, includes a layout being similar to the one presented for the tender. However, this layout is for what Veidekke notated as “Opportunities” in the headline. Going through the suggested opportunities (see the red box in Figure 11), one could be giving the perception that they are actually risks and it might be so that it is simply a mistake in the document. Either the headline is misleading, or the suggested opportunities is.


	Project no.:					
	Project name:					
	Created by:					
	Risk evaluation		Opportunity		Comments + how will opportunities be managed	
Opportunities	Low	Medium	High	Min	Probable outcome	Max
Technical						
A. Project implementation						
Contractual magnitude - Time schedule						
Work environment						
Environment						
Quality						
Choice of material						
B. Customer						
Customer						
Requirements on quality, environment and health and safety						
C. Work area						
Law and regulations						
Accessability to work site						
Climate						
Geotechniques						
Stock and depositon of ground material						
Land						
Water impact						

Figure 11: In the “Client and Economy” document, a similar structure as to the tender document is presented in one of the sheets.

The rest of the document, regarding risks associated with the Client and Economy, as well as the document related to “Quality, Environment, and Health, Working Environment and Safety” has a different layout from the document regarding tender, but risks are stored in a similar way, see Figure 12. However, the way the identification process is carried out is the same. This document also presents some general risks, but gives the opportunity to add more.

3.2.4 Phase 3 - Analysing risks

This phase deals with the analyse part in the “Risk and Opportunities” documents. The analysis is performed in the same way for each cycle, apart from the tender document as well as the “Opportunities” brought up in one of the documents of design and production.

When the risk and opportunities are listed, Veidekke introduces the tool “probability and consequences matrix”. This tool is mentioned by the prescriptive RMPs as “probability and impact matrix “, which is used to score risks. According to the prescriptive processes, the purpose of using impact and probability matrix is to prioritize risks in order to know which risks to put more focus on. In Veidekkes operational system, the approach is similar – the risk number will be used in order to know what appropriate response and degree of analyses the specific risk will require, which will further be explained in phase 4.

Veidekke states that the probability of the identified risks is estimated on a 1-5 scale, as can be seen in Table 3.

Table 3: Veidekkes definition of their probability scale.

Probability	Implication
1	Never happened in the construction sector
2	Few happenings in the construction sector
3	Has happened in the construction sector
4	Happens several times per year in the company
5	Happens several times per year within projects

The consequences, if an identified risk should occur, is estimated on a 0-5 scale, as can be seen in Table 4.

Table 4: Visualisation of scale numbers connected to certain consequences in different areas.

Assessment	People	Cost	Environment	Quality
0	No damage	No losses	No effect	No complaints
1	Minor damage	Minor costs	Minor effect	Small deviation from demands
2	Small damage	Little costs	Limited effect	Customer comments
3	Significant damage	Significant costs	Local effect	Larger customer comments
4	Substantial damage	Substantial costs	Large effect	Loss of customer
5	Event of death	Very large costs	Very large effect	Large loss of marketing share

Veidekke then explains, when the probability and consequence numbers has been estimated, that a risk number (R) is calculated by multiplying the number for the probability (P) with the number of the consequence (C).

The risk number will be stored in the document “Risk and Opportunities”. This step is the final step in the analysis phase. In the tender process, it also include a step where the risks and opportunities are priced with minimum-, likely- and maximum- value.

Veidekke also mention, besides the assessment above, that the identified risks should be classified as acceptable, unwanted, or unacceptable. However, it is not specified how to perform the classification, where the classification should be stored, and how to act based to the classification.

In contrast to Veidekke’s RMP, the prescriptive RMPs describes that one should look at, and gather feedback from earlier projects when analysing risks. Even if this might or might not be done in practice, it is not brought up as a tool in the operational system.

3.2.5 Phase 4 - Planning the risk responses

The final step in the use of the “Risk and Opportunities” documents involves the response work. Veidekke explains that a response has to be developed in time before the production work starts.

Depending on what risk number a risk was given, different responses need to be carried out, as can be noted in Table 5. If a risk is registered as “Low”, no specific actions need to be performed but still some observance need to be made. If a risk is registered as “Medium”, preventive actions need to be made. Finally, if a risk is registered as “High”, a deeper analysis need to be done.

Table 5: Veidekkes definition of necessary responses connected to a calculated risk number.

Risk number $R = (P) * (C)$	
Risk number (R)	Response
Low risk 1-4 = GREEN	Observe that the risk may be anticipated, but no demand to take any action
Medium risk 5-12 = YELLOW	Preventive action is demanded
High risk above 15 = RED	Depth analysis and action

Regarding the risks of Occupational, Health and Safety (HSE) area prescribed by law, responses only need to be made if the risk is noted as a threat, or if it could occur. It is stated in the operational system that according to the law, execution plans then need to be conducted. Other HSE risks are performed in the same way as described above.

However, there is no thorough explanation of how the responses in Table 5 should be carried out. For example, how does the preventive action and the depth analysis differ, how does one perform a depth analysis?

Veidekke further explains that if an action is supposed to be carried out, it should be an action in order to eliminate, adjust, or minimize the risk. Examples of actions are according to the operational system:

- Execution plans
- Inspection plans, check lists, measurement
- Changed execution/method/action
- Choice of machines
- Protective gear
- Deepened risk analysis including risk reducing action
- Routine/instruction
- Education, documented particular competence

Veidekke's RMP correspond with the prescriptive RMPs regarding the aim to provide a management plan. But yet again, the responses are only mentioned and no clear explanation is presented of how the responses are supposed to be carried out, nor how the result of the responses are supposed to be used in future work.

However, the responses that Veidekke presents correspond to some of the responses mentioned by the prescriptive RMPs; mitigation and avoidance. There is however no recommended example of the responses regarding risk transfer, risk acceptance or risk insurance. Furthermore, no examples of responses connected to opportunities are presented.

3.2.6 Phase 5 - Monitor, control, and manage the risks

Veidekke's operational system regarding risk management does not give a clear description of how the monitor and control phase is supposed to be performed. It is stated in the operational system that continuous meetings shall be held, production meetings, weekly meetings etc., where risks and opportunities shall be revised. Also, meetings shall be held if new working methods or if other conditions have changed. However, it is not explained how the information and results from the meetings should be stored. If the information that appears during these meetings does not get stored properly, there may be a problem to be able to evaluate the whole risk management process, which is an important standpoint in the prescriptive RMPs.

Finally, the operational system briefly explains that when the work for a certain risk and opportunity is finished, or when a preventive measure has reduced or eliminated, the risk/opportunity can be closed. What is meant by closing a risk is however not explained.

3.2.7 Summary of Veidekke's RMP

Veidekke's RMP is a simpler version of the ones brought up in the prescriptive RMPs. This does not have to be seen as something negative, since it could just as well be the prescriptive RMPs that cover far too much.

When overviewing Veidekke's RMP, one can see that it matches the prescriptive RMPs in many aspects. However, the arrangement and usage of different phases is not seen in written text in Veidekke's operational system, even though the information still can be found. The setup in this thesis is merely an arrangement which was interpreted in order to match Veidekke's RMP to the prescriptive models. By doing the classification, the prescriptive models could easier be compared to Veidekke's.

One of the starting points for the prescriptive RMPs, phase 1, is to plan the process in order to give the involved parties an understanding of how the work should be conducted, what needs to be done, and how it should be performed. This part is missing in Veidekke's RMP.

Further on, in phase 2, the identification of risks, Veidekke's RMP relies a lot on previous experience. The one tool besides experience that is mentioned is to use risk assessments performed by the client, subcontractors, or suppliers. In comparison to the prescriptive RMPs, more substantial tools and techniques are lacking in order to identify risks.

In Veidekke's RMP, documents are presented which shows similarities to what is presented in the prescriptive RMP. The documents cover many of the needed areas, but the documents are hard to understand and includes similar structures that is presented in different ways depending on where you look.

The analysis, being phase 3, is in many ways also similar to the prescriptive RMPs. Risks are analysed with a probability/impact matrix and later on responses are based on the calculated risk number.

In phase 4, suggestions of responses are mentioned in Veidekke's RMP. Comparing to the prescriptive RMPs, responses such as transfer, insurance, or acceptance is not brought up. Some risks in Veidekke's RMP are also, based on their risk number, said to need a depth analysis. How this deeper analysis should be performed is not brought up.

The last phase, phase 5, shows that monitor and control is not described thoroughly in Veidekke's RMP. It is merely stated that meetings are supposed to be held continuously, but it is not described how the results of the meetings are supposed to be stored or how to transfer knowledge to future projects.

3.3 Interview study

This chapter presents the results and analysis from the interviews. The interviews were carried out in order to get an understanding of how the employees at Veidekke work with risk management and if their risk management work differed from the explained RMP in their operational system.

The interviews were conducted according to the method found in Chapter 0, and specifically Section 1.4. The questions asked during the interview can be found in Appendix 1.

3.3.1 Definition of risk

The definition of risk varies between the interviewees. Some find it easy to find the words to describe risk, while others find it harder. The most common way to describe risk among the interviewees were with an example. Instead of talking about risk in a general way, interviewees described risks from experience.

However, as the interviews continued and the interviewees got more time to think about what risk really means to them, they were able to give more concrete explanations. Similar to the definitions in the literature review, some of the employees at Veidekke also sees risk as something uncertain and unpredictable.

“I define risk as an uncertainty. [...] when I am not sure about the outcome”

“It [a risk] is something unpredictable”

Furthermore, it became clear that employees with different professions connects risk to different subjects depending on what is most important for them in their work, e.g. the financial situation or employee’s health etc.

“When something does not work out in a good way. In our job [calculator] it’s when it does not work out financially. Then there’s other risks such as Occupational Health and Safety risks, but we don’t analyse those types of risks”

“Whether you will get home or not. Not only the risk that exists out on the site, but also the psychological risks. The risk of getting burned-out” – site manager

Also, a few interviewees conveyed the perception that risk has a lot to do with the individuals’ experience.

“We might not see the same risk factors, depending on experience and what you have done earlier”

This means that in general, in terms that risk imply uncertainty and unpredictability, risk may be equal to all the employees. However, in reality the perception of risk will diversify in the way employees carry out their risk management work.

3.3.2 Defining risk management

Before the interviewees’ risk management work was described, the interviewees were asked to define what they thought risk management entailed. Yet again, one could notice that the definition of risk management between the interviewees differed, some were more specific than others and interviewees were influenced by their field of work.

One of the operational managers gave a statement which correspond to a high extent with the definitions in the literature study, see Chapter 2, and specifically Section 2.1.

“To have a structure and to handle the risk problematic. To have a structure where you try to identify, quantify, and handle risks in some way.”

The statement indicates that the operational manager work with risk in a systematic way, and the process of managing risks is performed with clear steps and overlaps. However, even if other interviewees were not as precise in their description, it became clear during the interviews that the employees work with risk continuously.

Moreover, it also appeared, as for the definition of risk, that the interviewees’ definition of risk management depended on what they work with. For example, the calculator

associated risk management with the process of putting a value (price) on the risk, while the site manager associated risk with the process of ensuring the construction workers health and safety.

3.3.3 Describing their own risk management work/process

Before specific questions about the RMP of identifying, analysing, responding, and managing and control were asked, a brief and general perception about Veidekke's RMP as explained in the operational system was requested. Some of the interviewees could to some extent show that they knew about Veidekke's RMP:

"We have a described system were we look at high and low risks, along with high and low probability. Which then is put in a matrix"

"I think we have a fairly good system dealing with it [Veidekke's RMP] in the operational system"

However, others are not aware of the risk management tools at all. Even among the interviewees that were aware of the operational system's risk management tools, a scepticism emerged whether the function and usefulness of the tools were actually understood by the people who are supposed to use them.

"It is quite unusual that people understand exactly how the tools are supposed to be used"

However, this does not imply that these interviewees' do not work with risk management. Instead other methods and techniques are used, which is not specified in the operational system, depending on the employees' previous experience and working methods.

"I have been working so many years that I have created my own checklist, which have become second nature"

Instead of following the intended operational system, the interviewees merge the risk management work with other activities in a seamless way.

"It is not like I think: Today I am going to work with risk management in this project"

Several interviewees emphasize that they do work with risk management, but not in the intended way as the operational system describes. This indicate that the RMP in operational system could need some refinement.

"Yes, but maybe not in a super structured way. You do it, but maybe not so organised"
"I guess we are not that good at taking the time to do the documentation. The work is done continuously without any general method. Everyone has their own way of handling the tasks"

"Yes, but maybe not in a very organised way"

3.3.4 Identifying risks

Identifying risks is not a systematic process among the interviewees, one does not sit down on a meeting just to identify risks and no interviewee explains their process as if they would use tools such as brainstorming or SWOT-analysis to identify risks. However, risks are identified, and the process of identifying risks is something that is done from the beginning of the project when the tendering process begins. When a procurement begins, interviewees explain that procurement meetings are held where one subject on the agenda is said to be risks, or as they call it “challenges” or “break-down-questions”. By having this subject on the agenda, risks are identified and brought up piece by piece on several occasions and meetings.

An operational manager, as well as the project engineer, describes how they look through the framework documents which are received in the tender phase, and that it is read through and notes are made where uncertainties are found. Somehow one tries to compare the framework with the reality, using earlier experience.

“...you compare the framework documents with the reality, one reads through and tries to find glitches, things that may be stated several times, or things left out or missed”

Another way of identifying risks is by using a legal expert hired by Veidekke. The legal expert explains during the interview that he/she is often assigned to go through the tender framework documents. Based on the framework documents, the legal expert writes a risk PM where discovered legal risks are listed.

The operational manager explains how they in the beginning of a tender perceive the client as a risk. Therefore, they start to evaluate the client to see if it is a stable actor or not, which could influence the risk of whether Veidekke will get paid or not. One also evaluates the type of project in question in order to answer if it is a project that they are familiar with, or if it is a new type of project.

“To do new things are always connected with taking risks, [...] it is always easier to do things that you know”

However, it is explained that one does not have time to look through all the tender framework documents and drawings before starting the tendering work. Instead, risks will be identified when the calculators begin their work with the break-down list.

The interviewed calculator explains that when a procurement begins, framework documents are received and one tries to systematically go through these. When doing so, equivocations regarding the clients request might be found – things might be described in different ways. At this point, Veidekke must ask themselves which request is correct. Since it is not clear, interpretations of the documents have to be made.

The calculator also explains that they will soon start to use a new system in their procurement work, where a list is shown in the end of the project document with all identified risks. This list resembles what they today call the break-down list where all risks are described. This new software will act as a tool to enable systematic risk registration.

A practical way of identifying risks, as one interviewee explains it, is by using 3D-software during the design phase. The technical consultants can then identify risks which otherwise could occur during the production.

From the interviews it is also explained that the subcontractors' knowledge is used to identify risks. If there is something that might be considered an uncertainty in the tender framework documents, the sub-contractors will let you know, and this information could later be used to transfer the responsibility, making a "reservation" as Veidekke call it, in the tender.

One of the interviewees claim that when identifying risks "*...we have a document called risk and opportunities so probably they [the risks] go in there, or they go down on some kind of paper somewhere*". It is shown that the systematic process of identifying risks and writing them down might be lacking, but still, the work is done in other ways.

The same interviewee further says that when preparing a tender, you will get a result that hopefully come close to the actual production cost. This result will then be further analysed and each item/account will then be challenged to see if it is possible to lower the cost of the activity connected to that item/account, and decide which risks should be taken.

The calculator then gives an example when an offer from a sub-contractor has been provided, and how he/she has reasoned:

"...then you need to evaluate this and you might say that this is a price we can bargain on; we might get it down half a million. Then we decrease our tender to our client by half a million. Then that's a risk that we take, the price might go up. It is a calculated risk you take in order to win the project, and it is connected with how much we want the job."

Another example of identifying risks regards refurbishment projects. Then Veidekke cannot calculate the project's work hours in the same way as they do for new constructions. Instead of using unit times of one hour, Veidekke might put 1.2 hours for the same task. This is explained as an early identified risk.

"We cover for the risk since we know that it will take a longer time"

In the production process, the identification of risks is strongly connected to the execution plan of each task. In the beginning of each work task, the site manager or one of his site supervisor goes through the task and make an execution plan. During the development of the execution plan, thoughts of different problems that may arise will be identified. However, depending on the task that is being processed, the documentation will differ. The site manager claims that if the task is really simple, and has been made multiple times before, the risk identification may only be in the form of a discussion, with no official documentation. In other cases, when the task is more complicated and unique, a more substantial identification process is carried out, with clear documentation. But even when the risks are identified and documented, it is not always stored correctly, making it hard for other people to take a part of it.

3.3.5 Analysing risks

Analysing risks are discussed by the interviewees with examples, no systematic process of analysing risks is performed. A common risk is the ground work and the depth to solid ground. This will affect the length of the piles, and consequential making the price either higher or lower since one cannot know exactly how the depth varies. One interviewee gave the example when having Veidekke Bostad AB (in-house developer) as the client. The interviewee explains that since they do not know what the price will be, they make an estimation based on assumptions. Another interviewee who was asked about the same thing explains that they make a guess of the cost of the pile work. If they believe it would mean a high risk, they might choose to make a geotechnical investigation to give more information and therefore make a better guess. The interviewee then says that they have decreased the probability of the risk, but that the choice of how to act upon a risk is not done systematically. However, a different interviewee explains how they sometimes identify risks that is not controlled or analysed in the next step, they just see how it goes.

“I believe that it is that step that I feel that we lose a little”. In the end, the interviewee feels that it comes down to individuals and how thorough they are in their work.

When looking at work with external clients, it is explained that pile work is adjustable quantities and even if a geotechnical investigation has been executed, it might still be wrong or insufficient.

“Pile work entrepreneurs do not give a fixed price, and we have it as adjustable quantities towards our client. Then the consequence could be time. But we are probably not so good to account for this. Pile work will in the long run be a small part of the whole project.”

So a risk, being pile work, is first identified. To analyse this, they quickly conclude that it will not affect them on a price-basis since it is adjustable quantities when the client is external. So for some risks, the process could therefore be concluded to be quick and effective.

The question of how specific risk for a certain project is priced were answered by one interviewee as *“...then I guess we just need to come up with something.”* It is also discussed if they work with probabilities and consequence analysis but this is perceived as something many interviewees have heard about but does not use. *“I believe there are some matrix with that in the operational system, but I, or we, do not use it”*, instead experiences are used.

Another example of analysing risks would be in the case where two sub-contractors give different tender offers for the same work. An interviewee gives an example on installation work on a refurbishment project where one sub-contractor offers to do it for 1.5 million SEK and another for 2.5 million SEK. The interviewee explains that if this was a project where they knew they were the only one participating in the procurement, then they would go with the more expensive offer. The reason why, is because there is always a risk that the sub-contractors has miscalculated their offer which mean that the lower offer might not add up to the expectations of the project. Hence, there is a risk that Veidekke might not do profit.

But if the procurement would involve several entrepreneurs, the calculation process would look different. In that case, Veidekke has to be more detailed in their choice. Veidekke would then rather look into the cheaper offer and ask the sub-contractor if they have thought about everything in the provided documents.

The interviewee also discusses that it might be the case that the more expensive sub-contractor had not had sufficient time to make an accurate calculation. The sub-contractor may therefore just have added an extra amount on their offer to make sure they do not make a loss.

As explained in the identification part from the interviewees, the calculators will start using a new software. In the new software, a risk list can be produced and in this process, one can choose to put a price on the risks or not. This matches the process in the prescriptive RMPs, where risk is analysed with price assessment.

One example is given if there is a risk on a certain account on 1 million SEK, but if they would choose to put this extra million in their tender they will not get the work, so they might add half a million. Then it will be documented in the last sheet of the program that they have evaluated and priced the risk in a business manner. In order to analyse the price to add, the calculator explains that you need to consider the probability and outcome of the risk. It appears that this is done by experience and in a subjective manner, using probabilities to evaluate risks systematically is not performed.

As can be understood from the examples, the risk management work regarding the analysing phase is done at an individual basis. The employees have not implemented a systematic method, in accordance to Veidekke's RMP, to analyse risks.

3.3.6 Risk responses

According to the prescriptive RMPs presented in Chapter 2, risk response will follow the analysing phase. It became clear that it is not a systematic and structured way among the interviewees to connect each risk with a response. Even if the interviewees does not consider and work as systematic with risk response as the prescriptive RMPs explains it, when asked questions about it they do use similar risk responses.

Example of this is when several interviewees mention how they can make a "reservation" in the tender to the client. This correspond to the risk transfer technique which is one of five responses brought up in the prescriptive RMPs.

Examples of reservations in the tender could be, as mentioned before, pile work, but also polluted ground. During the tender calculations, when Veidekke confront an activity that they cannot put a price on, Veidekke will make a reservation in the tender and bring this to the client. Regarding pile work and polluted ground one interviewee explains that:

"Then we make a reservation. Most often we have a certain amount of work or length [in the contract]. What we cannot calculate we make a reservation for, or we use a fictive number, or you need to go out and make a geotechnical investigation."

The use of a list, as earlier mentioned as the break-down list, is also brought up from several of the interviewees. In this list one has to, during the tender calculations, decide whether or not you can put a price on the risk or if you need to make a reservation.

“We work with an uncertainty list where we write down all things being unclear in the tender; it doesn’t have to be all risks but also restrictions which we want to have in the tender. Then we work through this list with the operational manager and then we either try to make a reservation for the points written down or we put a price on them.”

It is also brought forward that insurances are used in order to handle and respond to certain risks. One of the operational managers also explains that if they feel the need, extended insurance can be used. This type of risk response is also brought up in the prescriptive RMP.

The legal expert explained how the legal and contractual risks, which are discovered when the tender framework documents are gone through, either can be dealt with by negotiating, pricing, or using insurance. These are three of the five mentioned responses in the prescriptive RMPs, being transfer, accepting, and insurance. By negotiating the risk, the tender framework documents could be changed and therefore not making Veidekke liable for the risk – being transfer of the risk. Pricing a risk would for Veidekke be to accept the risk, but in return of having the client pay extra for this. Using insurance is also brought up in the theoretical RMPs.

Reducing the likelihood or financial effect on a project, being “Mitigation” as a risk response, was also discussed among the interviewees. A use of mitigation could be related to Occupational Health and Safety risks, where if a risk is discovered, once tries to minimize the risk by using extra safety precautions.

The risk response technique regarding “Acceptance” could also be the case where Veidekke accepts a risk without negotiating a price with the client. One could for instance use active acceptance, meaning that a contingency reserve is established to fund the risk if it were to occur. Contingency reserves were mentioned by one of the operational managers, but it was claimed not to be used. However, the calculator explains how they sometimes increase the amount on a certain account since they know it comes with a risk, this could be seen as a contingency reserve since the account should be beneath its budget if the risk would not occur. Accepting risks could also be related to when an interviewee explains how they should decide whether to use weather protection on the construction site or not. If not using weather protection, one has accepted the risk and the consequences which could arise.

As stated earlier, one can understand from the interviewees that the employees work with risk and risk responses but not always in the systematically and well documented way as it is explained in the prescriptive models. This statement is also confirmed during the interview with one of the operational managers. Further, most of the responses mentioned in the prescriptive RMPs can be found in the interviewees’ statements, but the interviewees are not always aware that they use them.

3.3.7 Monitor and controlling risks

How the interviewees carry out the monitor and control part is not clear. The interviewees give a disjointed perception of how the monitor and control part is performed.

According to an operational manager, monitor and control is conducted via meetings every third month where forecasts are made on financial accounts connected to certain activities. This would be one way to regularly observe the status of risks, and notice if they change. However, these kind of monitor and control events had much, or only, to do with economical objects, and therefore economical risks.

“Forecasts are conducted quarterly where accounts are overseen. They will for example show if we have miscalculated the time to perform certain activities”

Furthermore, it is not clear how the information from the meetings are stored. If it is written down and whether or not it is available for everyone to see.

Another operational manager mentioned that during the production, they have a set of meetings – monthly, weekly, and/or daily. At these meetings, sub-contractors, blue-collar workers, supervisors and site managers are involved and risk, among other things, are one part on the agenda which is discussed. Risks that are critical and need instant treatment are discussed, but also risks that the staff anticipate in the future.

The meetings that are mentioned above have some kind of risk management aspect, but still, risk monitor and control does not seem to be the main topic. From the interviews, it became clear that the interviewees do not systematically make check-ups of the outcomes of risks. This also imply that they do not store specific information of that matter. The prescriptive RMPs underline that data from current and previous projects should be stored and easy to find in order to make the risk management work easier to perform for future projects.

During the production, monitor and control was mentioned by the site manager in two aspects. The first aspect regarded the Occupational Health and Safety risks, in order to control the risks which could occur, safety rounds were done once every week, or every second week. However, the site manager adds the fact that the week consist of four more days, meaning that even if the safety rounds are good, they will not reflect the status at the construction site every day. The other aspect regarded financial risks, these were considered during financial meetings with the operational manager. The site manager believes that there is room for improvement, but that it is probably a question of available and/or allocated resources.

Moreover, one interviewee could not relate his/her work with risk monitor and control, but argued that it would be good if it was performed. Similar, one interviewee stated that the monitor and control part should be implemented but in reality, the execution is not well documented.

3.3.8 Knowledge transfer

Transferring knowledge from one process, being tender, design or production, to another is essential in order to make sure that the identified risks are not forgotten. Below the process of transferring knowledge between different phases are discussed, and lastly some general concerns are brought up.

Tender process to design process

An operational manager explained how they try to keep the documents from the tender processes and transfer it to the people in charge of the design process, this in order to transfer the knowledge and information that has already been created. However, he/she further explains how this work is sometimes insufficient;

“I think that we might not always get through and that we get a glitch between the tender phase and design phase, or to production, depending on the type of contract. We do not get it [the risk list] with us in a good way, to work further with it.”

The operational manager explains that the employees need to be able to ask for help more easily in order to transfer knowledge. It is described that when a site manager is introduced to a new project, it is easy for that individual to redo much of the work and make the project his/hers. Then everything somehow starts over.

“...you don't always ask the individuals, especially the calculators which has been involved in the making of the framework for the contract. There you actually have a large source of knowledge and knowledge transferring.”

It is explained that the employees only start to ask questions when they get stuck on something. Instead, the operational manager feels that they should talk to each other more proactively. If the employees worked more interactively before they get stuck at problems, a lot of time and money could have been saved.

Design process to production process

Between the design process and the production process, an operational manager argues that little knowledge is lost. This is because it is almost the same people that work in both processes. If you had a problem in the design process, then you will carry that with you when the production starts. However, both the operational manager and the project manager stated that sometimes when the site manager enters the project late, problems may still arise. But because there are often project engineers or project managers that follow the project into the production process, those individuals become the bridge of information between the processes.

Another interviewee states that when the project is about to start in production, a delivery of information is made between the calculator and the production team where they go over the calculation and related questions.

The interviewed site manager explains how at a start of a project in production, a start-up checklist is used in order to make sure that everything that needs to be done before production has been completed. In this checklist, Risk and Opportunities is at the top. When asked if the site manager has worked with this document or got it handled over to him it became clear that it has not been received, the site manager although explains that it is not even the idea that he/she should receive it. However, risks in the Risk and

Opportunities documents should reach the site manager, both according to Veidekke's described process and the prescriptive models.

If the site manager is not able to participate in the design process, which is preferable at Veidekke, the interviewee explains how they instead could go away for two days in order to go through the whole project with the calculator, operational manager, and the production team. The site manager expressed this as a very good way to transfer knowledge, but that two days was not enough. They most often do not have time to go away longer than two days, but when asked if he/she believed that this in the end would make them save money, the site manager was confident they would.

A project engineer mentions the use of a log list. In the log list, questions that had arisen during the design phase is written down. The log includes information about who asked the question, when question was asked, what the answer was, and who answered it. This could be seen as a tool for knowledge transfer that the site manager can use if not being a part of the design phase him-/herself. However, this list only grows and there is no good way to filter the available information, so the interviewee gives the perception that it might be hard to use it in an easy way.

General issues relating to knowledge transfer

When discussing knowledge transfer with the project manager, it is stated that they do look at past calculations and that they get knowledge transferred from the project, things that had gone bad or deviated from the plan. Several interviewees however feel that they can improve their work in transferring knowledge between different projects, and that they during a period of time has talked about systematic transfer of knowledge at Veidekke.

The legal expert explain how knowledge of legal risks are transferred between different projects mostly by the education which the interviewee conducts at Veidekke. During these educations, example from earlier projects are brought up so that the employees can learn from this, but the interviewee states that it is only a limited amount of people who attends the courses which means the knowledge is not spread throughout the whole company. Further, the legal expert also claims that in some cases the knowledge from tender or design is not fully transferred to the production. There are times when risks in the production process occur which was brought up earlier, and could therefore have been avoided. According to the legal expert, this is mostly because those who are supposed to execute the project in the production has not gained enough insight in the documents prepared in an earlier stage.

When discussing knowledge transfer with the site manager, the risks regarding Occupational Health and Safety (HSE) was on the top of the list. These risks were example handled by a weekly notification from the one responsible for HSE at the regional office. This notification contains all the mishaps which had occurred at the different sites during the week. This is according to the site manager one way to learn from others in the organization, so that themselves could prevent this mishap from happening at their site. However, the site managers further claim the even though the information reaches the employees at the working site, it is usually only quickly reviewed and then archived. Hence, there is no thorough analysis or discussion of the given information.

It becomes clear from the interviews that there is no list or document that includes all the identified risks, with their probabilities of occurrence and responses. An operational manager explained that there is no such systematic way of working. When the document from the operational system is mentioned, with the risk list, he/she explains that they do not use it. But the interviewee emphasize that it might be good to use.

Finally, a question was asked whether the interviewees make a final check-up when the project is finished, to see how the risks played out. An operational manager explains that they perform a final meeting where experience from the project is shared among the participants. The operational manager says that they do not really bring the documents regarding risks and compare them to the outcome. One could argue that this is a good opportunity to overlook how the risk did play out but the check-up is not carried out. However, the operational manager does agree that it would be interesting to observe what kind of risk that they had thought of in the beginning of the project.

3.3.9 Knowledge and thoughts regarding Veidekke's RMP

During the interviews, the interviewees were asked about the operational system, and what they thought about Veidekke's RMP and the available documents. Most interviewees gave the perception that they do not know exactly what is said in the operational system, or even know about the required documents that are available.

"I don't think like that [about using Veidekke's RMP]. It might say so in the operational system but I have not read it."

"Well I felt that I knew what was said in the tender phase and specifically about larger project, but it's not like I can see the documents in front of me. I know the documents regarding risk assessment on Occupational Health and Safety. I also know that matrix connected to risks and when it becomes 1 times 3 or 3 times 9."

"If you have worked a couple of years you don't go in and read specifically what it [the operational system] says."

An operational manager explains that he/she does not actively work with the documents and does not write down the risks in them. Neither does he/she look at the matrix with probability and impact. Furthermore, the interviewee mentions that he/she is not used to control a project by using such documents, so the documents are not demanded. It is though brought up by the operational manager that maybe he/she should demand them, but feels unsure about it.

One interviewee explained that *"If we look at Veidekke's operational system it is not like we sit down and fiddle around with those matrixes"*, while another interviewee knows it exist but does not use it either; *"It would take a week to fill that in, but then again you might save 100 000 SEK"*. Furthermore, the later interviewee explains that the information available in the operational system is a bit too much. An example with the probability and impact matrix, consisting of 0-5 types of values, is that the interviewee feels that it might be enough with merely three degrees, in order to make it easier and quicker to use. A different interviewee simply states that he/she has not looked at the operational system about RMP, but when showed the documents he/she realizes that he/she has seen them but simply does not use them.

Regarding the required risk management documents in the operational system, most interviewees explain that they have seen it but does not use it. One however, explains that they have to fill in the risk lists in order to get through certain gates, example to get the go for the start of a project. It is though unclear if it is the exact documents from the operational system or if the interviewee means something else, he/she states that “yes, something similar, this about putting a value on things we do”.

The question whether the interviewees feel that it would be good or not to use these documents was later brought up, and they all agree that they could see the benefit of doing so. However, the interviewees claim that it comes down to routine. It is about the amount of time needed to perform the task, and to ensure that everyone understand what is being done and what it will be used for.

When asked if the documents would be good to use or if changes needed to be made, the interviewees states:

“The amount of material need to be reduced. It has to be clear and easy to use so that people actually uses it. It is not prioritized high enough to do this, you have your experience and you only use the documents you need”

“Yea maybe, but I don’t know what I would get out from it. I can understand that there is a higher or lower risk for some things. This could be a help in order to identify risks.”

“... I believe that they might be for too large contracts, they should perhaps be a part for smaller contracts as well.”

In one of the documents, a decision needs to be made about the cost of a risk where one has to decide the least, probable, and maximum cost. An interviewee asks how one should know which value to put under “max”, and argues that it is a subjective estimation. Furthermore, the interviewee questions which number that should be used later on when the budget is supposed to be created. If something should be marked red or yellow or put as a four on a scale, what does that mean and how should one know which to choose? This is not clear according to the interviewee and the operational system or the documents does not say how to use the numbers regarding cost that you have come up with.

An interviewee also stated that it might be good for larger project but for the standard projects which he/she is involved in, going from 60 to 100 million SEK, it would be too ambitious. However, if the lists and documents would be simplified, he/she believes that it would be used. It is further explained that there are certain risks that occurs which they were not prepared on, and if you would use the intended RMP you might have pulled through better. It is stated that one should probably consider to reserve time for doing the risk management work during the whole project. A different interviewee however tells the opposite regarding on which project sizes the RMP is for, he/she believes that the intended RMP and documents are for large contracts, and that they instead should be for smaller contracts as well.

When the interviewees were confronted with the documents and the intended RMP at Veidekke, several interviewees gave the perception that it in all look like a good system with good documents. An interviewee claims that when looking at the documents

he/she sees nothing wrong with them, and that they actually are better than the documents he/she is using at this moment. In the intended documents there are headlines regarding areas one should think of when identifying risks, and example of risks in each area, which the interviewee sees as positive. Other statements regarding the documents are:

"...when it is not clear how it is supposed to be used, it is like we use it only because we have to. But it is good that it exists. It gives the indication that we must deal with risks and think about them. It is the explicitness/clarity that is missing."

"This [the RMP documents] looks really good. [...] I should start to use this more."

It is clear that they are not against using these types of documents, but they simple do not do it due to the lack of clarity in the documents, and instead experience is used and risks are identified along the way. The missing factor seems to be that they are not introduced to the RMP that Veidekke intends to use.

3.3.10 Human aspects

From the interviews, one could understand that the human aspect plays a crucial role in the interviewees' risk management work. Interviewees mention that it is important to have the right people as a part of the group, and that they can work together and use all the knowledge which the participants possess. An interviewee says that:

"When you participate in a lot of meetings there can be those who dominates the conversation and who cannot be quiet, and then it does not work. It is important to find the right individuals."

The fact that the risk management work often becomes a subject of subjective thinking was especially stated by one interviewee;

"How should one know what a number four represents on a scale? It is arbitrarily and the judgement is affected by the outcome one seeks, one is influenced by their own ambition and will."

"...if you compare if I fill in a list [the risk documents in the operational system] in comparison to if someone else does it, it becomes a matter of personal thinking."

One interviewee states that his/her boss would never consider to take a risk, and therefore the boss could be seen as a risk averse individual. This further affects the interviewees work and it is explained that it makes him/her more careful when considering risks.

4 Discussion

In the following sections, the prescriptive RMPs and the result from the case study will be discussed. Moreover, future research and recommendations to Veidekke will also be presented. In Appendix 2, a summary of the discovered differences and equivocations in Veidekke's RMP against the prescriptive RMPs, can be found.

4.1 Definitions

As stated in Chapter 3, and specifically Section 3.2.2, the definition that Veidekke present in their operational system is quite specific in comparison to the general definitions of risk defined in the literature. Veidekke does include some general perception of the unknown, but according to their definition, only risks that may affect time, economy, environment and Occupational Health and Safety are of concern.

Moreover, during the interviews it became clear that the perception of risk differs depending on the interviewees' background and profession. Notable is that the definition of risk was described in more general terms higher up in the hierarchy. For example, the operational managers used uncertainty and unpredictable as terms to describe risk, which is similar to the definitions in the literature. However, when moving down the hierarchy, the definitions of risk were described with examples and the definitions were expressed in conjunction to the interviewees work. This situation may have arisen because of the operational managers' task to have a greater and more total responsibility of the business, compared to the other interviewees which have more specific tasks and therefore their definition of risk become more specific.

4.2 Prescriptive RMPs

Even though the three RMPs have their own plan and procedures to carry out the risk management work, one could notice that they had much in common. This is despite that they all were created during different years, and at a first impression have different set-ups with their own interpretation of the phases. But in the end, all three RMPs handle the same areas. The content is more or less the same, and the biggest difference is where in the processes a certain area is taken care of and how many steps the process is divided into.

The reason why the RMPs have so much in common may be because the RMPs stem from the same origin. The process that all three RMPs carry out is not a whole new way of thinking, instead, it is a well-known mind-set that managers have been practicing during a long time. It is a mind-set of structured and rational thinking, which has been analysed and described in a new way for others to understand more easily. The different versions that are available today, may therefore only be different takes on the same rational and systematic thinking used before. This was also observed during the interviews where the interviewees conveyed the mind-set of commitment and that they understood the significance of managing risks, but it was not performed in the same systematic way as the prescriptive models or Veidekke's theories has presented it.

All RMPs are more or less specific and structured. Each phase has described a precise method of implementation. However, even though PRAM (Chapman, 1997) has created a process which is well organised, the process is iterative. Since the process is

iterative, it results in a quite fuzzy process when adapting it to practice. On the one hand, each phase should be finished before the next phase is initiated, but on the other hand, one should repeat to the previous phase and add new information that has come up to the surface during the project. The whole concept of the process being iterative also makes it hard to be systematic.

Furthermore, the theoretical RMPs gives the perception that risk management requires a whole lot of time. However, in reality this might not be achievable. The managers that are supposed to control the risk management work is most likely already swamped with tasks that are critical to perform. The time that the RMPs require is not available and not always a priority. Instead, the RMP should be merged with the work that the employees already carry out. There need to be some sort of continuity of the work. This leads to the way of work that Veidekke carry out. At Veidekke, no unique risk management meetings are held, instead they have chosen to bring up the question of risks as a part of other meetings, e.g. at Virtual Design and construction meetings (VDC), economy meetings, planning meetings, and safety site inspections. The findings of this sort of procedure also gives an understanding of why some of the interviewees had a problem of defining risk management. Veidekkes RMP is fundamentally embedded in their routines, which make the employee work with risk even though the employees may not know that it aligns with the intended RMP.

However, during the investigation of the prescriptive RMPs it also became clear that the processes not only require a lot of time, but that the RMPs are also very substantial. The prescriptive RMPs has chosen to present the process at such a detailed level almost making it hard to comprehend. For example, the need of using all the tools can be questioned. Yet again, the RMPs introduces such an extensive work load, making the possibilities of performing all the risk management tasks difficult. Therefore, there should be some sort of simplification of the process. A process which is easy to understand, and that only contain the essential tools that are most common. It could be argued that one should not get to many options, making it hard to decide which is the most useful, instead one should only be recommended a limited selection of tools and techniques to make it easier to initiate the risk management.

4.3 Veidekke's RMP

When comparing Veidekke's RMP to the prescriptive RMPs, one can see that there are many similarities. Even if the different phases are not spelled out, one could find that the introduced material in Veidekke's RMP very well could be divided into phases which corresponds to the prescriptive models. To get a better holistic perspective of the system, these phases could be arranged in accordance to the prescriptive models, which was done in the presentation of Veidekke's RMP in this thesis. It could then be showed that one work through the phases of planning, identifying, analysing, responding, and lastly monitor and controlling.

Noted at the very start in Veidekke's RMP is that there is almost no difference of the process in tendering, design, and production. Neither does the prescriptive RMPs show differences regarding if one is working in the different processes, but one could argue that theory, as well known, is not practice, and therefore one needs to adapt the prescriptive framework to its organization. Even if the content, and the different phases of the RMP, could be similar, one should take into concern that a calculator, design

engineer, or a production team works very differently. The difference of their process of risk management is evident from interviews. A calculator for instance should have the possibility to link its risk management work with the computer system they work with, and perhaps not use the checklist given to those working in design and production. Still, there need to be a clear routines of documentation for knowledge transfer. Hence, the result and thoughts of their risk management work should be summarised in the mutual documents. A calculator also focuses more on pricing risks and give an interval of the believed price of the risk. However, a site manager is probably working more with monitor and control, most risks should already be identified. The RMP could therefore benefit if such a system, depending on the process one work with, would be adapted and developed with the involved individuals.

The prescriptive RMPs shows a systematic approach of handling risks, however, it is clear from these that the process is also iterative. One does not identify all risks in a given session, the different phases of the prescriptive RMPs is overlapping. This is also shown in the interviews, in that risks are identified as they come along. This could give the perception that it is a non-systematic approach, or it is just an approach that means that their work is overlapping. Identifying risks as they come along is therefore not something that should strictly be considered as not following a structured RMP. Many of the interviewees are not aware of how often they actually work with risks, since it is a part of many people's daily work. It should be made clear in Veidekke's RMP, as explained in the operational system, that the phases are overlapping and that the process is iterative.

Even if Veidekke's RMP resembles the prescriptive models, the connection between Veidekke's theoretical RMP and their practice is lacking. It is shown that the interviewees work with risks, but not fully according to their RMP in the operational system. Some interviewees also believe that these types of RMPs are for larger projects, while others believe that it should also be adaptable to small projects as well. It seems to be a divided understanding on which projects the RMP should be good for, which should be discussed among the co-workers at Veidekke. The disagreement may have arisen because of the time consuming documents. Because the employees know that the RMP is time consuming, some only want to include it in bigger projects where more money are at stake. If the documents were more efficient, maybe the resistance against the RMP work would not occur as frequently.

The study has also shown that Veidekke's theoretical RMP includes misspellings, grammatical errors, texts that comes twice in one session, templates which has been changed so that it includes risks from a specific project, and references to non-existent documents. This lowers the confident of the RMP, which was also explained in several interviews. If the RMP is supposed to be used and followed, the first impression is important and should show clarity and structure.

Phase 1 – Planning the RMP

The planning phase does not exist in Veidekke's RMP as the prescriptive models explains it. The purpose of planning the RMP is to make sure that everyone involved in the process will understand how one will work with risks, who is responsible for what, what tools to use, how to present and communicate the work, and to get the holistic perspective of the RMP. The authors of this thesis emphasizes that adding this phase will benefit the RMP.

Phase 2 – Identifying the risks

Identifying risks is leaned upon past experience and no specific risk techniques, such as brainstorming or SWOT, is presented. Identified risks is to be added in the document “Risk and Opportunities” which is available for the RMP. The amount of tags in each document makes it hard to understand how to use the documents. Using headlines in one tag instead of many, could be preferable in order to make it easier to understand. Also, the different documents vary a lot depending on which document or tag one chooses to follow, but the content and the result is more or less the same. This gives an inconsistent and confusing perspective. The risk list should be simple and well explained in order to make it more useful and make the employees understand the benefits.

Phase 3 – Analysing risks

Veidekke’s analysing phase resembles the prescriptive models to a great extent. However, to analyse risks the prescriptive models encourage to use feedback from earlier projects. This is an important tool in order to analyse how a risk can fall out and should therefore be implemented in Veidekke’s RMP. In order to do follow up risks and learn from other projects, monitor and control becomes important – this is discussed further down.

Phase 4 – Planning the risk responses

Veidekke choses to present several different ways of how to respond to risks. The different responses are merely examples of specific actions, even though some general responses are mentioned they are not described thoroughly. Furthermore, Veidekke’s examples are more or less only connected to mitigation and avoidance, considering how one can decrease the probability or impact of a certain risk. Comparing to the prescriptive RMPs, risk responses such as the ability to transfer risks to another partner, or buying insurances, is not brought up. It is however explained by the interviewees that these types or responses are used. These different response techniques should be considered to be incorporated in Veidekke’s RMP.

Phase 5 – Monitor, control and manage the risks

The monitor and control is an essential part of a RMP. However, Veidekke’s monitor and control phase is quite vague and there is not much information to gather from the operational system. The interviewees also show a lack of using monitor and control, and one does not systematically perform check-ups of the outcome of risks that were found earlier. This part should be considered to be further developed in order to make sure that the team working with identification of risks, and later on brief the team who will work with the monitoring of the risks. This phase includes to learn from previous work and to transfer knowledge to future projects. The knowledge transfer part is also lacking in Veidekke’s theoretical RMP, and should be considered to be further developed. How one project’s risks can help to identify and understand risks in a similar project should be further developed. This could be done by establishing clear routines and simplistic documentation which is stored at one designated place for any Veidekke employee to take part of in the future. However, to transfer knowledge between projects, see Section 4.5, is recommended for future research.

4.4 Human aspects

According to Smith et al. (2006), risk is always a part of peoples' lives. During a working day, employees are confronted with decision-making and often, even if unconsciously, one needs to make some sort of risk analysis. The interviews have showed that this is applicable to their risk management work. Many are not aware of the concept of risk management, and the process which one should work after, but still they do work with risks every day. At the beginning of the interviews, many feel unsure about whether they work with risk or not, but when discussing how one should work with risks they become reminded of that this is actually what they do, but not in the systematically described process.

Aspects which could induce groupthink according to the literature could be groups with a strong leader and the procedures for debate are not established, where there are immediate pressures to reach a solution, and a lack of methodical approach, see Chapter 2 and specifically Section 2.5.2. This is interesting since in the case of Veidekke, a strong leader such as the operational manager is holding the meetings which includes the risk process, solutions are often needed in a short amount of time, and according to this study, a methodical approach for working with risks is missing among the interviewees. This creates a risk for groupthink to occur and people could promote unity in the group instead of disagreeing or bringing up other aspects. Many are probably not aware of the effects of groupthink, and it should therefore, according to Smith et al. (2006), be promoted at meetings to have an open dialog where disagreement is encouraged.

Further, the interviewees explained how the human aspect can play a crucial role in their risk management work. Examples is brought up of persons which dominate the conversation, and how this affects the possibility of others in the group to influence their work. A systematic process is not always enough, but one need to put together a team which can work effectively with the process.

Prospect theory shows how individuals rate a negative risk much greater than a positive risk, even if the outcome in monetary terms is the same. This study has shown that risks are in many aspects considered with negative events, and even it exists, striving for opportunities is not as common. The prospect theory explains why such could be the case. In order to work with opportunities and look at where one could earn example money or time, a way of adapting a more rational approach should be considered.

Group influences on shared cognitions is another aspect which could give rise to problems in a group. When working with risks at Veidekke, employees with different professions are present, such as calculator, operational manager, site manager, or project engineer. This is considered positive since it includes different professions, which decrease the probability of shared cognitions.

As good as a process can be explained in an operational system, subjective decisions often emerge. Interviewees asks themselves how one should know if you should choose to put a number two, or a number four on a 1-5 scale when valuing the impact of a risk. It should be noted that Veidekke's RMP give guidelines of what a certain numbers mean.

It is difficult to act objectively when work is influenced by own experience, which means that it is hard to get an approach to risks which reflects the whole organization. It could be the case that certain risks occur often, and therefore the organization should be able to get example of values for a specific risk, by looking at how often it has occurred and what the impact in those cases has been. Just because a certain risk never occurred to a specific individual's project, does not mean that it should be given a low value when evaluating the probability of that risk. The risk might have happened several times in other projects where the interviewee was not participating. Also, if it is a subjective approach, groupthink emerging from a strong leader could mean that those opposing a certain decision of what value to choose may not raise concerns.

4.5 Future research

Through this study of Veidekke's RMP, similarities and differences to the prescriptive risk models has been identified, as well as between Veidekke's theoretical process and practice. It has been shown that even if Veidekke's theoretical RMP is in many ways similar to prescriptive models, implementing their model so that is used by their employees is at this moment lacking. Even if some conclusions can be drawn to why employees does not use the RMP, how to implement it as a process throughout the whole organization should be further researched.

The construction sector has high employee turnover, which leads to the issue, which also has been showed in our results, that it is most often the individuals that learn and not the organization. Therefore, how to be able to transfer knowledge to the organization, so that it constantly improves even if individuals are replaced, is another aspect which would be an interesting future study.

Further, this thesis has looked on Veidekke's operational system as well as its employees' perception of the system and their own risk management work. Future research could include participating in meetings where risk is discussed in an actual project, or to follow a project for a certain period of time in order to study how risk is managed in a real project.

It has furthermore been shown that even if a systematic process exists and is used, the human aspect will play a crucial role. Future research on the effects that may influence the group, its dynamics, and decision-making in the RMP would be of value.

4.6 Final thoughts

How the results of this thesis can be adopted to other organisations within the construction sector is difficult to predict since the study only focused on one specific company. However, companies which share a similar structure and may have similar difficulties with systematizing and implementing their process, could benefit from the result of this study. The ones interviewed has also worked for other companies, which means that the difficulties may exist in more than a specific company in the industry.

Moreover, there needs to be a better understanding why the risk management work is performed. Today, no significant knowledge transfer is performed, and because of the lacking documentation, during the execution of projects, it will continue to be hard to realise. Therefore, information about why risk management is useful must be presented

and employees must understand the worth of risk management and continuously work with documentation. Only then can information about the project be analysed. It will make it possible to understand what went wrong, what went right, and there can be discussion about how things should have been done differently.

4.7 Recommendations to Veidekke

This study has shown that the overall process which Veidekke presents in their operational system is in many ways similar to the prescriptive models, but some improvements should be made. The interview study has shown that Veidekke's employees work with risk management, but not in the intended way which Veidekke explains in their operational system. In order to improve Veidekke's RMP, the following suggestions are made:

- Structure the RMP with clear distinguish between the desired phases to easily facilitate an understanding of the process.
- Include employees from each division to take part of the creation of the processes of risk management, in order to effectively reach sufficient tools and procedures that aligns with the work to be completed during the processes of tender, design, and production.
- Establish user-friendly routines for documentation of information, in order to improve knowledge transfer. Also simplify the documents to be used in order for the employees to easily be able to start using it.
- Mediate the usefulness of risk management and make sure that the employees are given an introduction to how the RMP is intended to be performed.

A full list of differences between Veidekke's RMP and the prescriptive models, as well as detailed suggestions by the authors, can be found in Appendix 2.

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6 Appendix 1 – Interview questions

The interviews are performed semi-structured, see Chapter 1 and in particular section 1.4.2. The questions for the interview were as followed:

About the interviewee

1. What is your background? Education, earlier work?
2. What do you work with at Veidekke?
 - a. In which phases? Market, tender, design, warrant.

Definitions

3. How do you define risk with one sentence? (try to not use examples)
4. How do you in a few words define risk management?

Veidekke's risk management

5. How would you define your risk management work?
6. Specific questions on the risk management process:
 - a. How do you identify risks?
 - b. How do you analyse risks, example if a certain method is used to understand the risks better and/or to put a probability and impact, using risk numbers to prioritize the risks?
 - c. What types of risk responses to you use in order to handle the risks?
 - d. How do you present and structure the risk management work and data?
 - e. How do you follow up the risks, are there ways to see which risks that have occurred and which that has not?
7. Whom are you in contact with for your risk management work?
8. How do consider the work between the different phases of tender, design, and production?
 - a. Is the knowledge transferred between the different phases? If yes, how?
9. Is knowledge transferred between projects?
10. How well do you know the risk management process and documents available in Veidekke's operational system?
11. What do you think about the material that is available?
 - a. Are you positive to its layout and how it is presented?
 - b. If not, how do you feel that is should be presented?

7 Appendix 2 – Summary of discovered differences and equivocations in Veidekke’s RMP compared to prescriptive RMPs

The following list summarises what have been found when analysing and comparing Veidekke’s RMP to the prescriptive models, as well as what has been found during the interviews and suggestions made by the authors of this thesis.

Veidekke’s RMP

- Structure the RMP with clear distinguish between the desired phases to easily facilitate an understanding of the process.
- Include employees from each division to take part of the creation of the processes of risk management, in order to effectively reach sufficient tools and procedures that aligns with the work to be completed during the processes of tender, design, and production.
- Establish user-friendly routines for documentation of information, in order to improve knowledge transfer. Also simplify the documents to be used in order for the employees to easily be able to start using it.
- Mediate the usefulness of risk management and make sure that the employees are given an introduction to how the RMP is intended to be performed.

Phase 1 – Planning the RMP

- A planning phase barely exist, which purpose is to give the risk management team an understanding of how the RMP is supposed to be performed, which tools to use, how to present and communicate the work, and to get a holistic perspective of the RMP.

Phase 2 – Identifying risks

- Veidekke has not implemented a substantial guide on how to systematically discover risks.

Phase 3 – Analysing risks

- Veidekke’s RMP does not urge the benefit of systematically gather information and feedback from earlier projects, even if it might be done in practice.

Phase 4 – Plan risk responses

- An explanation of how the responses should be carried out is missing, or how a depth analysis should be performed.
- General risk responses in Veidekke’s RMP is only mentioned vaguely and is not described, instead examples are used. Also, some of the prescriptive risk responses are not presented.
- No risk responses to opportunities are presented.

Phase 5 – Monitor and control

- The operational system regarding risk management does not give a clear description of how the monitor and control phase is supposed to be performed.
- For monitor and control, meetings shall be held but no explanation of how the risks should be handled during these meetings exist, nor does it say anything about how the information and results should be stored
- Since no thorough explanation of how to store information from the risk management work is available, there may be a problem to be able to evaluate the whole risk management process, which is an important standpoint in the prescriptive RMPs.
- The knowledge transfer part is lacking and should be considered to be further developed.

Interview study

- Hard for interviewees to define risk in general terms.
- Several interviewees are not aware of the available risk management tools.
- Among those interviewees being aware of the operational system's RMP, a scepticism emerged whether the function and usefulness of the tools were actually understood by the employees.
- Several interviewees emphasize that they do work with risk management, but not in the intended way as the operational system describes.
- It is shown that the systematic process of identifying risks and storing them might be lacking, but the work is done in other ways.
- Several interviewees has heard about the tool regarding probability and impact matrix, but does not use it.
- The interviewees work with risk and risk responses, but not always in the systematically and well documented way.
- From the interviews, it become clear that the interviewees do not systematically make check-ups of the outcomes of risks. This is stated as important in the prescriptive models in order to make future projects benefit from earlier performed RMPs.
- Interviews state that monitor and control should be implemented, but in reality the execution is either not performed or not well documented.
- Working with knowledge transferring between projects is perceived as insufficient among the interviewees, and their work is explained to be able to be improved.
- Interviewees state that if a site manager arrives late in the production (hence, not part of the design phase), problems with transferring knowledge emerges.
- The Risk and Opportunities documents is not properly handed over to the site manager.
- No list or document that includes all the identified risks, with their probabilities of occurrence and responses, exist – no such systematic way of working is performed.
- Risks are not followed up in the end of the project, identified risks are not compared to the outcome.

Thoughts regarding the operational system

- Most interviewees gave the perception that they do not know exactly what is said in the operational system, or even know about the required documents that are available.
- Subjective estimations are performed when putting values under “least”, “likely”, and “max” in the Risk and Opportunities documents, interviewees perceive this as something challenging.
- Even if intervals, least/likely/max, is given on a certain risks cost, interviewees question which number to use in the budget.
- Veidekke employees are not introduced to the intended RMP at Veidekke.