FACULTY OF SCIENCE AND TECHNOLOGY

MASTER'S THESIS

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Abstract

In 2022, Hæhre Entreprenør AS implemented a new management system. It is through this system that Hæhre manages their risks and ensures a standard methodology for risk management throughout the company. Therefore, it is essential that the risk management processes described in Landax are working optimally. The goal of this master's thesis is to determine whether Hæhre's risk management aligns with current risk science and identify areas for improvement. To achieve this, a qualitative study was conducted, analysing a total of 100 documented risks and reviewing Hæhre's holistic risk management document, as well as other relevant materials. The main findings of the study revealed that Hæhre often lacks important aspects in terms of the risk literature in various areas of the risk analysis process and other aspects of their risk management. After discussing the areas where Hæhre can enhance their risk management processes, 10 points for improvement were identified.

Abstrakt

I 2022 implementerte Hæhre Entreprenør AS et nytt styringssystem. Det er gjennom dette nye styringssystemet at Hæhre håndterer risiko og sikrer en felles metodikk for hvordan risikoen håndteres i hele selskapet. På grunn av dette er det viktig at risikostyringsprosessene som beskrives i Landax fungerer optimalt. Målet med denne masteroppgaven er å finne ut om Hæhres risikostyring er i tråd med dagens risikovitenskap, og å identifisere områder hvor de kan forbedre sin risikostyring. For å finne ut av dette er det gjennomført en kvalitativ studie hvor det ble utført en analyse av totalt 100 dokumenterte risikoer, i tillegg til en gjennomgang av Hæhres helhetlige risikostyringsdokument og andre dokumenter. De viktigste funnene fra studien viste at Hæhre ofte mangler viktige aspekter i henhold til risikolitteraturen på mange områder av risikoanalyseprosessen og andre deler av deres risikostyring. Etter å ha diskutert områdene hvor Hæhre kan forbedre sine risikostyringsprosesser, ble det identifisert 10 forbedringspunkter.

Preface

This master thesis marks the end my five years at the university of Stavanger. First and foremost I will like to thank my supervisor Eirik Bjorheim Abrahamsen for valuable inputs and help both during the period when the master thesis was written, and the semester before with tips on how I could create a research question, Secondly I will like to thank my external supervisor from Hæhre Heidi Mørkhagen Wikøren for inputs on the thesis and procedures done in Hæhre. I will also like to thank Frida Grindvold from Hæhre with help In form of practical challenges like providing office space for me in Hæhre's premises. And Irene Lysebo Svea for inputs on the thesis, setting up meeting with key personnel and of course allowing me to write this master thesis for Hæhre. I also would like to thank my fellow co-students that regularly uses the Frisk room for many good memoires and academic discussions. Lastly I would like to thank my family for support not only during this master thesis, but during all five years of my time at the university of Stavanger. Without all of you, this master thesis would not be possible for me to achieve, Thank you.

Espen Myrvold Holtet

2023

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1 Introduction

1.1 Background

Up until 2022, Hæhre Entreprenør AS, hereafter referred to as Hæhre, used Microsoft Excel as their main risk management tool. However, in 2022, this changed when they implemented Landax, a new management tool that can also be utilized for risk management. This implementation was aimed at standardizing the assessment and management of risks across different projects, ensuring a cohesive approach to overall risk at the enterprise level as well as within individual projects. The implementation of Landax is still ongoing and has yet to be fully implemented in all projects within Hæhre.

The aim for this master thesis is to uncover whether the risk management in Hæhre works as it is intended, find out how Hæhre works in relation to risk, provide Hæhre with information on how to implement principles, methods, and tools into the management system based on risk literature, as well as specific recommendation on how the business can enhance methods and expertise related to risk management at all levels.

1.2 Research question

In light of the background for this thesis, the following research question was formulated: "How does Hæhre work with risk management, and in what ways can Hæhre improve its risk management practices to enhance workplace safety and strengthen the overall quality of risk management?" To investigate potential improvements, the following additional questions have been developed:

1. How does Hæhre manage risk?
2. What exactly is done in Hæhre when assessing an risk?
3. What are Hæhre's principles for risk management, are these appropriate and do they contribute to a solid risk management process?

By answering these question I will able to figure out if there are:

1. Are there any Challenges/issues with what is being done?
2. Is Hæhre's risk management in line with risk science?
3. Specific or overall Points that will improve Hæhre's risk management.

1.3 Scope/limitations of the thesis

This master's thesis will focus on how Hæhre manages risks related to Health, Safety, Environment, and Quality (HSEQ) at both the project level and within the organization as a whole. It should be noted that this thesis will not explore the management of risks in other fields.

1.4 Structure

This master's thesis is structured into five main chapters. The second chapter will present the theoretical foundation used in this thesis. In chapter 3, the methodology applied for this thesis will be presented and discussed. Chapter 4 will present the results of the analysis and findings in the holistic risk management document. in chapter 5, I will discuss these findings in relation to the theoretical foundation. Lastly, chapter 6 will conclude this master's thesis and present the points of improvement for Hæhre's risk management.

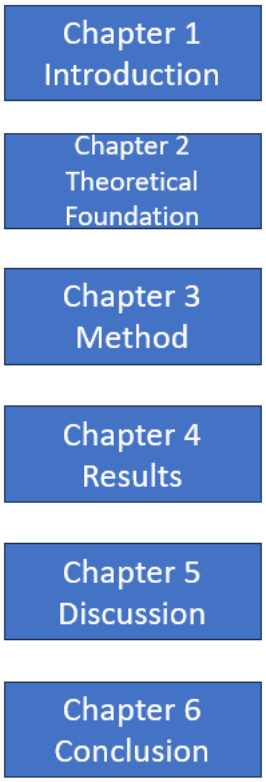

Figure 1 Structure of the thesis

1.5 Context

This chapter will provide the reader with a brief introduction to Hæhre Entreprenør AS and its organizational structure within the HSEQ department, starting from top management down to the project level.

1.5.1 Hæhre Entreprenør AS

Hæhre is one of Norway's largest construction contractors with almost 50 years of industry experience. It was established in 1974 and has since participated in many of Norway's largest infrastructure projects (HÆHRE ENTREPRENØR, n.d. a). Hæhre is part of the Infra Group, which is one of Norway's largest construction companies consisting of independent divisions. Together, these divisions create a strong professional environment within the construction sector (Infra Group, n.d.). Hæhre is divided into different projects across Norway, with a headquarters that supports all of these projects. Currently, Hæhre is working on 11 different projects throughout Norway. The projects range from smaller projects valued at 50 million Norwegian kroners to some of the largest in the country, valued at 5.6 billion Norwegian kroners (HÆHRE ENTREPRENØR, n.d. b).

1.5.2 Organizational Structure

The following subchapter will provide a brief overview of the organizational structure within Hæhre's HSEQ department, starting from top management and extending to the project level. It is important to note that not all projects have the same organizational structure. The structure of a project will depend on its size. In this case, the organizational chart for project level is illustrated using a larger project. Regardless of the project size, there will always be at least one HSE resource available, and on smaller projects, they often have additional responsibility for quality and environment.

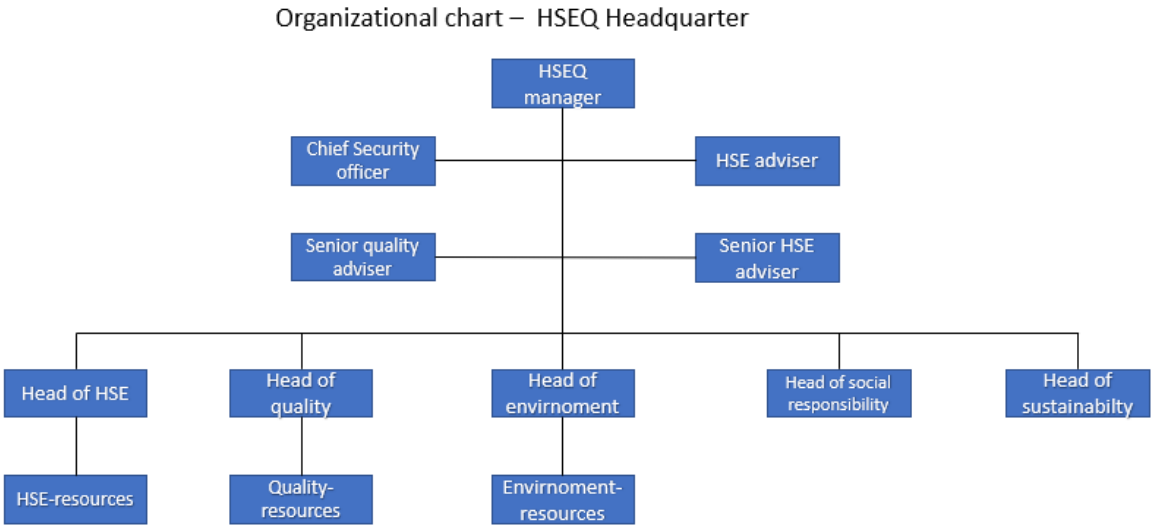

Figure 2 Organizational chart of the HSEQ department in the headquarters

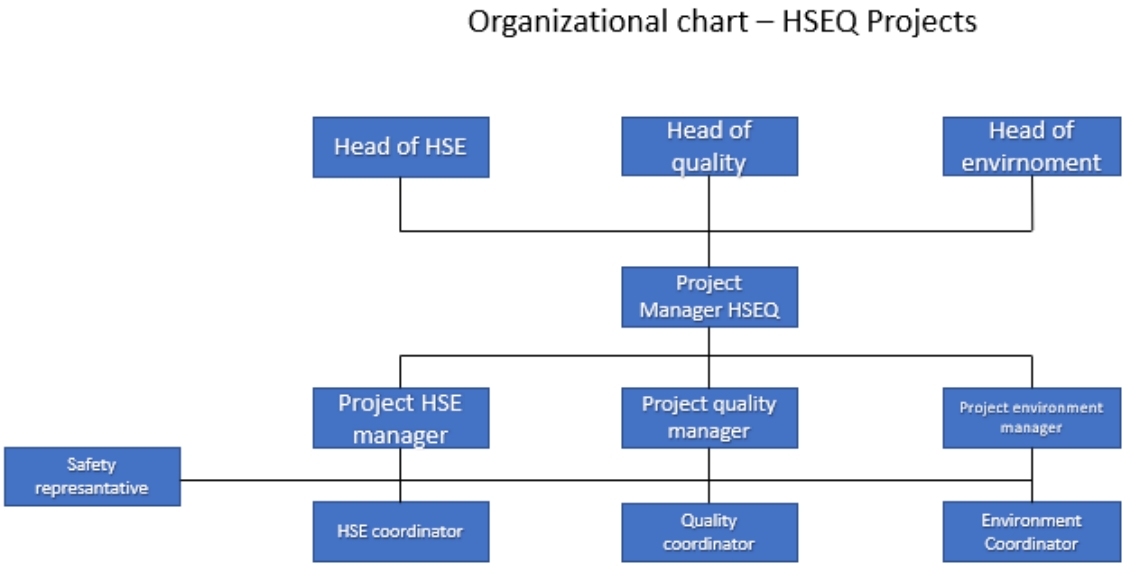

Figure 3 Organizational chart of HSEQ department on projects

2 Theoretical foundation

2.1 Risks and its different perspectives.

Based on the conviction that a scientific field needs a solid, well defined terms and concepts that are universally understood, many institutions and scholars spent much time trying to provide a definition that can be used as a standard for key terms in the risk analysis field. However, these attempts have failed, and experience showed that is it unrealistic to agree on one unified set of definitions (Aven et al., 2018, p. 3).

The iso standard defines risk as “The effect of uncertainty on objectives” (Standard Norge, 2018, p. 1). However, there are some problems with this description of risk. According to Aven (2017), it is Confusing, has no scientific justification, and it is tough to understand what it is stating. Why is it confusing? Aven comes with an example: When performing an activity, the outcome of this activity is either one or zero fatal accident. The objective can then be “no fatal accidents”. What is the effect of uncertainty on this objective? That the activity results in a fatal accident? If so, the fatal accident is not the effect of uncertainty but rather the effect/consequence of the activity, and it is the effect/consequence that is uncertain before the activity is performed (Aven, 2017, p. 1).

There is broad agreement that risk captures two dimensions. The first dimension is something we as humans value is at stake, a consequence related to an activity. The second is the uncertainties; here, there are different ways one can (A) conceptualize the idea and (B) measure and describe risk and uncertainties. Unfortunately, ISO 31000 fails in regard to both these dimensions. Utilizing other sources, such as the SRA glossary, is therefore recommended when looking for definitions that will help to understand risk (Aven, 2017, p. 2).

The Society for Risk Analysis (SRA) believed that it is possible to develop a standard glossary. Allowing for different fundamental concepts and making the distinction between overall qualitative definitions and their associated measurements was the key to accomplishing this; hence the “Society for risk analysis glossary” was created (Aven et al., 2018, p. 3).

The SRA glossary overall qualitative definitions of risk. (Aven et al., 2018, p. 4)

1. Risk is the possibility of an unfortunate occurrence.
2. Risk is the potential for realization of unwanted, negative consequences of an event.
3. Risk is exposure to a proposition (e.g., the occurrence of a loss) of which one Is uncertain.
4. risk is the consequences of the activity and associated uncertainties
5. risk is uncertainty about and severity of the consequences of an activity with respect to something that humans value.
6. Risk is the occurrences of some specified consequences of the activity and associated uncertainties
7. Risk is the deviation from a reference value and associated uncertainties.

There are different approaches one can use to measure and describe risk in order to make a judgment about the size of the risk. Which method to use depends on the situation of the risk because there is no suitable method in all kinds of situations. In well-known situations, expected consequences can be informative, and one needs to use a set of metrics that meets the need for the decision support. (Aven, 2019, p. 59) The SRA glossary has some examples of different risk metrics/descriptions (Aven et al., 2018, p. 4):

1. The combination of probability and magnitude/severity of consequences
2. The Triplet of Si, Pi and Ci. Si is the ith scenario, Pi is the probability of that scenario, and Ci is the consequence of the ith scenario. the “i” is the number of the scenario. for example S1= scenario 1. P1= probability of S1 and C1 is the consequence of S1.
3. The triplet of (C‘,Q,K). C‘ is one specified consequence, Q is a measure of uncertainty associated with the C‘ and K is the background knowledge that supports C‘ and Q, K includes a judgement of the Strength of knowledge (SoK).
4. Expected consequences (damage, loss) this can be computed by:
   1. The expected number of fatalities per 100 million hours exposed (Fatal accident rate, or FAR) or the expected number of fatalities in a specific time period (Potential loss of lives, or PLL)

2.2 Risk management Process

The Risk management process is a systematic process that covers all activities of applying policies, procedures, and practices related to risk. Figure 4 illustrates the process and includes activities from creating the context setting scope and criteria. The risk assessment process includes risk identification, risk analysis, and risk evaluation. How to treat the risk. Communication and consultation. Monitoring and reviewing. Recording and reporting of risk. (Standard Norge, 2018, p. 8)

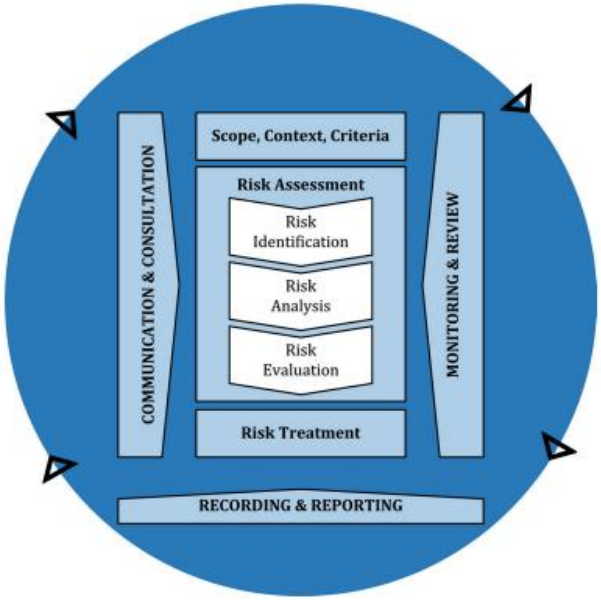

Figure 4 Risk management process (standard Norge, 2018, p. 9)

The risk management process can be used on strategic, operational, program, and project levels and should be an integrated part of the management decision-making process. The process should also be integrated into the organization's structure, operation, and processes (Standard Norge, 2018, p. 9).

2.2.1 ISO 31000 Risk management guidelines - Issues

The ISO 31000 risk management standard provides an organization guidelines for how to manage risk that the organization face. It gives a standard method for managing all types of risks for all industries and sectors and can be applied to all activities, including decision-making on all levels. (Standard Norge, 2018, p. 1) ISO 31000 is a document that can help organizations to reach their objectives, improve the identification of opportunities and threats, and better improve the organization’s use of resources for risk treatments (ISO, n.d.). Before we move on to the risk management process, there is a need to address some issues related to ISO 31000 with respect to risk science. As the standards are a voluntary guidance document

offering advice on managing risk, we need to be critical. Does the standard enhance the risk and safety, or does it only further the use of principles and methods that are insufficient and lacks quality? (Aven & Ylönen, 2019, p. 280).

Before we mention the issues there are several non-controversial features on an overall level from the standard where current scientific knowledge are being represented and agreed upon (Aven & Ylönen, 2019, p. 282):

- the importance of leadership and commitment in risk management
- Risk assessment provides a useful tool to inform the decision-makers and stakeholders on risk.
- The need for a structured process on how to use risk assessment in risk management

The standard focuses on meeting objectives that have some obvious strengths but also weaknesses. The problem is that when the focus is on meeting objectives, a compliance regime often appears where goals are set to meet task achievements, which does not improve the overall performance (Aven & Ylönen, 2019, p. 282).

As mentioned earlier, a problem with the ISO standard is how it defines risk. To add to this, we need to talk about how ISO 31000 characterizes uncertainty as this description is not up to date on current risk science, As it only considers likelihood (probability) into consideration when expressing uncertainty. For example, when expressing a subjective probability, one must reflect upon the knowledge and strengths of knowledge (SoK) that these judgments are based upon (Aven & Ylönen, 2019, p. 232).

There are eight principles that the ISO 31000 standard highlights. Even though the principles in itself seem reasonable, it lacks scientific argumentation for why these are the chosen principles for risk management. In addition, key principles should be formulated and, equally important, state what is good risk management, good risk management processes, and good frameworks. If one were to judge whether or not a risk management system is robust, it could be deemed so in relation to the ISO 31000 standard. However, when looked into with a scientific view it will be judged weak. The SRA provides guidance on strategies with good risk management based on scientific knowledge. (Aven & Ylönen, 2019, p. 282).

Lastly, In many places, critical terms like uncertainty, knowledge, and information are mentioned in the standard. However, it lacks an explanation of what these terms are. Providing no guidance on how to express uncertainty. This is a problem considering how central uncertainty is concerning its definition of risk (Aven & Ylönen, 2019, p. 283).

2.3 Planning – Scope, context and criteria's

Before the actual risk assessment is conducted, it has to be thoroughly planned. Good planning is essential to ensure that the risk management process is effective in its risk assessments and that the suggested risk treatment options are effective and made possible (Standard Norge, 2018, p. 10). The planning step/phase is one of the most crucial part of the risk assessment process. Without good planning and an understanding of what we want to achieve, it is hard to get the required results that we wish for (Rausand & Haugen, 2020, p. 61). This step consists of problem/issue definition, clarifying who the stakeholders are, setting study objectives, Establishing relevant principles and approach, and Data and information gathering (Aven & Thekdi, 2021, p. 74).

2.3.1 Scope and purpose

The risk management process can be used on different levels. Therefore it is important to clearly address the scope of the assessment, the goals that need to be taken into account, and the coordination of these goals in relation to the organization's goals (Standard Norge, 2018, p. 10).

When constructing the scope of an risk assessment, the following factors needs to be taken into consideration (Standard Norge, 2018, p. 10):

- Goals and decisions that needs to be taken.
- The expected results for each steps taken in the process
- Time, place and specific inclusions and exclusions.
- Tools and techniques that are relevant for the risk assessment.
- Areas of responsibility, Resource needs, and records that are to be kept
- The relation to other projects, processes and activities.

The goal of the risk assessment needs to be clearly announced so that all parties involved can work towards the same goal without the need for special communication (Lathrop et al., n.d., p. 7). It is essential to clarify the goal early on; if the goal of the risk assessment is not clear from the beginning, it is likely that the results from the assessment will not give sufficient decision support for the actual decision-making (Rausand & Haugen, 2020, p. 62).

2.3.2 Context

Those involved in the risk assessment should be aware of the broader circumstances where actions and decisions will be taken based on their assessment (Standard Norge, 2019, p. 13). This is because the context is determined by the understanding of the external and internal environment. When creating the context, it needs to be seen in relation to the framework for risk management set by the top management (Standard Norge, 2018, p. 10). It is important that one understands the contexts because (Standard Norge, 2018, p. 10):

- The organisation goals and objectives guides the risk management.
- Risk sources can come from organizational factors.
- The purpose and the goal of the risk management process can be mutual connected to the organizations goal.

Usually, the study objective in the risk assessment has to comply with some laws and regulations. It is important that the analyst is familiar with these when performing the risk assessment. In addition to being familiar with laws and regulations, the analyst must also be familiar with the internal requirements and guidelines given by the organization (Rausand & Haugen, 2020, p 65).

Engagement of stakeholders

Involving the stakeholders in the risk assessment helps to ensure that the information that the assessment is based on is valid and applicable; by involving the stakeholders, they will understand why the decisions are being made. It does not matter if a person is included in the risk assessment; stakeholders and all those with useful knowledge should be identified and their perspectives taken into account (Standard Norge, 2019, p. 13). It is important that all stakeholders are systematically identified, consulted, and engaged so that all stakeholders would agree that they were adequately communicated and involved on their: concerns, perceptions, involvement in naming, framing, and scoping of the risk management problem, involvement in the decision-making process, and the implementation process (Lathrop et al., n.d., p. 9).

Criteria

In relation to the goals, The organization should decide upon how much risk it is willing to take on and set some criteria. The risk criteria should be seen in relation to the framework for risk management and adjusted accordingly for the purpose and scope of relevant activity (Standard Norge, 2018, p. 10). The organization's goals, values, and resources should be

considered and reflect upon the criteria set. Also, the criteria should be consistent with the policy and the statements made about risk management. It is vital that even though the criteria are to be set early on in the assessment process, they remain dynamic. And regularly updated if there is a need for it (Standard Norge, 2018, p .11).

2.3.3 Communication and consultation

In order to successfully assess and manage risk, effective communication has to be at the core of risk management (Renn, 2008, p. 201). The purpose of communicating and consulting risk is to help relevant stakeholders understand the risks they are facing, the basis for the decision-making, and the reason why specific measures are implemented (Standard Norge, 2018, p. 9). The goal of communicating and consulting risk is to (Standard Norge, 2018, p. 9):

- Ensure that different viewpoints are taken into account when deciding upon risk criteria, and when evaluating risks.
- Give sufficient information to give a better overview of risks, and decision making
- Create an understanding of being included, and feeling ownership among those that are affected by the risks.
- Gather different expertise together for each step of the risk management process

2.4 Risk Analysis

Risk Analysis can be defined as a "Systematic process to comprehend the nature of risk and express and evaluate risk with the available knowledge" (Aven et al., 2018, p. 8), and is a combination of the Risk identification, risk analysis, and risk evaluation (Standard Norge, 2018, p. 11). We do a risk assessment so that we get a better understanding of the risks, so we then get a better foundation for answering questions like what can go wrong? What are the main risk contributions? What is the effect of implementing a specific measure? (Aven & Thekdi, 2021, p. 75) The information we gather during the risk assessment is used to identify measures, provide decision support, provide input to other analyses, and determine whether or not a risk is acceptable or not (Aven & Thekdi, 2021, p. 74).

2.4.1 Risk identification

In the first step of the risk assessment, we need to identify the initiating events. The identification of initiating events is a critical part of the assessment because one cannot deal with risks that are not identified (Aven, 2015, p 38.). The purpose of risk identification is to discover the risks that can either help a company achieve its goals or hinder it (Standard

Norge, 2018, p. 11). This process can be something that becomes a routine job; if so, one needs to be aware when doing the risk identification for that project that they do not copy similar risks from previous analyses. This is because even though the risk from a different project is of the same type, one may overlook certain aspects relevant to the new project that were not to the previous one (Aven, 2015, p. 38).

Risk identification should be a creative process, often by brainstorming ideas of what risks a project may be facing. Usually, it only takes 20% of the time to identify 80% of the risks, which are well-known risks. The remaining time (80%) will be used to find the last 20% of risks. Adopting a structure and systematic method is, therefore, essential so that we can capture these less familiar risks. (Aven, 2015, p. 39)

Risk identification methods

This sub chapter will present some methods used for identifying risks.

Checklist methods

A Hazard checklist is a list of hazards or hazardous events. The checklist can be based on past experience and previous hazard logs. The checklist should be made specifically for a certain process or operation and should be seen as a living document that needs to be reviewed and updated regularly (Rausand & Haugen, 2020, p. 264). When we perform a hazard checklist analysis, a strict procedure is not usually followed. The analysis can be done without any formal guidance. However, it is recommended to prepare a suitable checklist for the object in question so that important potential hazardous events are not excluded. The checklist can be questions related to the hazard/event or a list of hazards/events that is the starting point for identifying specific events related to the object (Rausand & Haugen, 2020, p. 265). There are some advantages and limitations to the checklist method: Advantages in the checklist method (Rausand & Haugen, 2020, p 265):

1. An easy tool to use, so it can be applied by people with no background in risk analysis.
2. Uses experience from previous risk assessments
3. Ensures that the common and obvious problems are not overlooked
4. Can reveal hazards otherwise overlooked in the design process
5. Is suitable for concept design, because it requires minimal information about the installation.

Limitations in the checklist method (Rausand & Haugen, 2020, p 266):

1. Is limited to previous experience, so hazards that haven't been seen previously can be overlooked
2. Does not encourage an intuitive/ brainstorming thinking, and gives little insight into the nature of hazards.

The checklist method is a generic but helpful tool for most risk assessments but should only be used in installations where the hazards have been studied in more detail elsewhere. Otherwise, other methods for risk identification should be applied (Rausand & Haugen, 2020, p. 266)

Job safety analysis (JSA)

JSA is a simple method that is used to review job procedures and practices in order to identify hazards and determine measures that will reduce the risk for the job that is going to be carried out (Rausand & Haugen, 2020, p. 278). The JSA is carried out by the personnel that is performing the task and should consist of a "JSA leader" (preferably a supervisor), Line manager, HSE representative, and operators that are carrying out the job (Rausand & Haugen, 2020, p. 281). JSA is an effective and standard tool because it can discover hazardous conditions and unsafe acts otherwise overlooked during routine management observations. (Rausand & Haugen, 2020, p 278).

A JSA has three primary purposes. These are (1) Nonroutine jobs; these are jobs that are considered to have significant risk and are done on rare occasions or only done once. (2) dangerous routine jobs, typical jobs that are known to have caused accidents or incidents in the past, are analyzed so that safety is improved (Rausand & Haugen, 2020, p. 278). The last one is (3) New work procedures. JSA can be used for establishing instructions for new jobs that occur. The objective is to ensure that hazards the personnel is exposed to are identified before the job begins (Rausand & Haugen, 2020, p. 279). There are seven steps when performing a JSA. Figure 5 covers the process. The middle part is different steps from 1 to 7. To the figure's left are the inputs to the different steps, and the figure's right covers the outputs from the steps (Rausand & Haugen, 2020, p. 280).

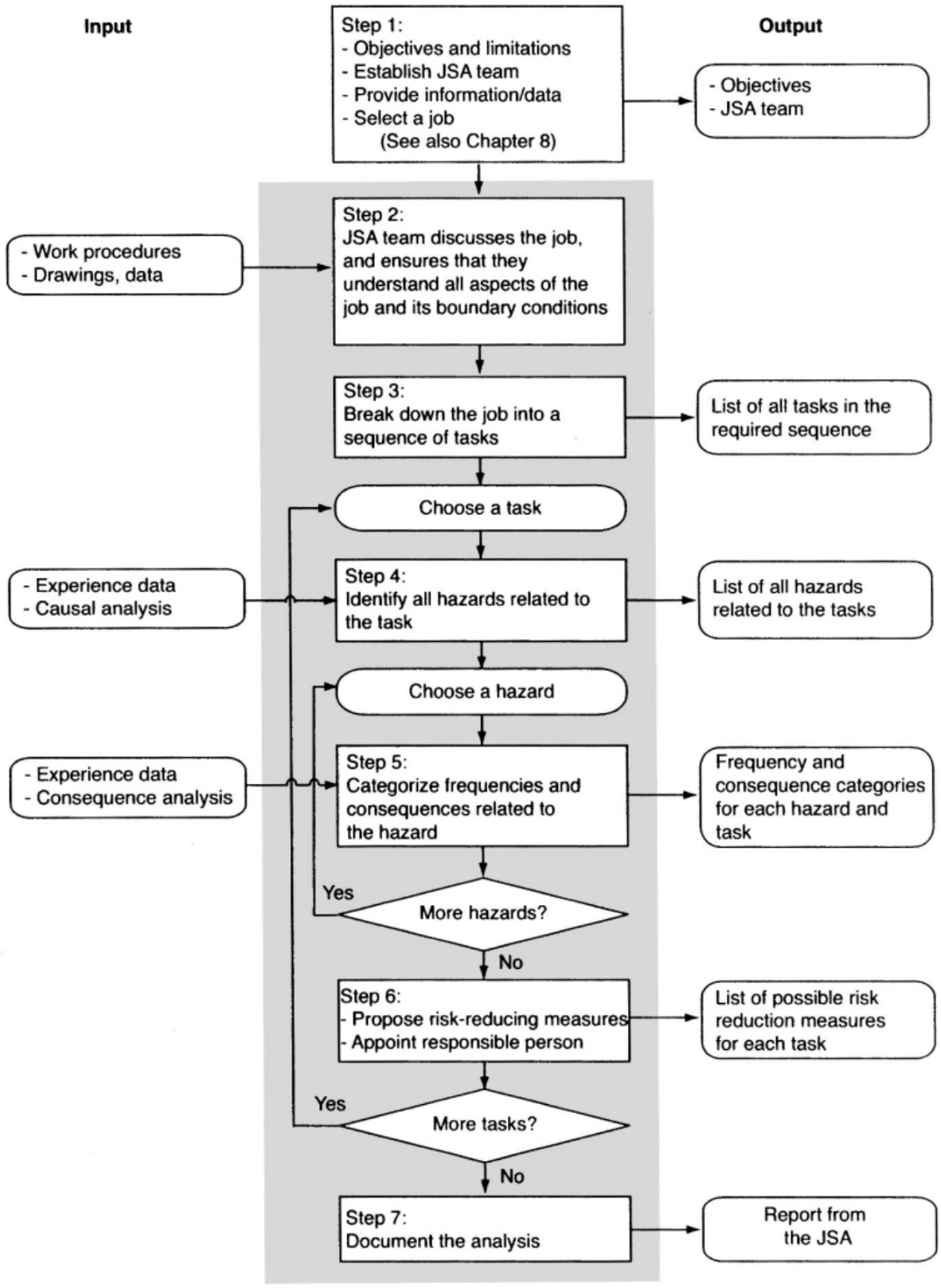

Figure 5 JSA process (Rausand & Haugen, 2020, p 280)

Advantages of using an JSA (Rausand & Haugen, 2020, p 287):

- Operators gets training in safe and efficient work procedures
- Operators awareness of safety issues are increased
- New employees are introduced to are introduced to safe work routines
- Provides instruction before nonroutine jobs start
- Safeguards that need to be in place are identified
- Employees participation in workplace safety are increased
- Positive attitudes towards safety is promoted

Limitations of using JSA (Rausand & Haugen, 2020, p 287):

- Is too Time consuming for complicated jobs
- Not a structured method so can therefore be too superficial
- Is not suited for uncovering potential problems when extensive coordination is required.

SWIFT

The structured what-if-if technique (SWIFT) is a technique where one employs systematic brainstorming where guide words in combination with phrases are used in order to identify risks. The phrases often used are “what if” and “how could”(Card et al., 2012, p. 24). For example, by using SWIFT, we ask, “What if a fire started on the construction site?” by answering this, we find out what the consequences of a fire might be. Then move on to “How could a fire start at the construction site?”, here we identify the risk sources so we can later come up with measures related to these.

The SWIFT technique focus on high-level processes. Because of this focus, the process is quick and takes up little time. The downside of this, however, is that some hazards may be overlooked compared to the more detailed analysis (Card et al., 2012, p. 24). The team performing a SWIFT analysis needs to have an experienced team working with it in order for the analysis to be reliable and “complete” It should consist of at least one person who is familiar with the process. The number of team members depends on the complexity and size of the installation/project/system (Rausand & Haugen, 2020, p. 321).

The goal of the SWIFT analysis is to identify all hazards and hazardous events, with their causes and consequences, evaluate if the safeguards introduced are adequate, and decide

whether or not actions/ risk reduction measures are needed to control hazards/ hazardous events (Rausand & Haugen, 2020, p. 317).

The SWIFT analysis can consists of these 8 Steps (Rausand & Haugen, 2020, p. 317):

1. Plan and prepare
2. Identification of possible hazards and hazardous events
3. Determine causes of the identified events
4. Determine the consequences of the identified event
5. Identify existing barriers
6. Assessment of the risk
7. Propose improvements
8. Report the analysis.

Advantages of using the SWIFT analysis (Rausand & Haugen, 2020, p. 322):

- Can be applied to all types installations, operations, processes or projects as it is very flexible tool.
- Creates a detailed record of the hazard identification process.
- Utilises experiences of operating personnel as part of the team.
- Is quick and simple tool

Limitations of using the SWIFT analysis (Rausand & Haugen, 2020, p. 322):

- Is not inherently thorough and foolproof
- Works on a system level, meaning that lower level hazard may be overlooked
- Highly depended on checklist that are prepared in advance.
- Heavily depended on the experience and knowledge of team.

2.5 risk Assessment

The risk assessment's main objective is to present an informative picture of the risk (Aven, 2015, p. 1). How detailed the analysis depends on the purpose of the analysis, available information and its reliability, and available resources (Standard Norge, 2018, p. 12). The risk assessment is done so we can (Aven, 2015, p. 3):

- Establish a risk picture.
- Compare different alternatives and solutions concerning the risk.

- Identify important factors, conditions, activities, systems components with respect to risk.
- demonstrate the various effect of risk measures

The points above provides the basis for (Aven, 2015, p. 3):

- what alternative and solutions to choose while in the planning phase.
- Choosing between different solutions and measures. Find out what measures can be implemented to make the system less vulnerable.
- draw conclusions if various solutions and measures meet the stated requirements.
- Set requirements for solutions and measures, this can be in relation to the performance of the preparedness system.
- Documenting an acceptable safety and risk level.

In some cases, there can be more than one appropriate approach for the analysis method that can be applied. Therefore it is important to consider all plausible alternative analysis approaches and to consider if the chosen approach is selected in a logical process. The decision-makers shall also be consulted on the implications of choosing an alternative analysis approach (Lathrop et al., n.d., p. 15).

The risk assessment includes (1) Cause analysis; the purpose of the cause analysis is to examine how an initiating event occurs (Aven, 2015, p. 39). (2) consequence analysis, the goal of the consequence analysis is to identify all consequences for all initiating events identified in the cause analysis (Aven, 2015, p. 40). This is because one event can have several different consequences in different categories, such as economic loss, environmental damage, HSE related consequences (Aven, 2015, p. 41). When both cause analysis and consequence analysis are complete, they can be combined into a bow-tie diagram, more on the bow-tie diagram in section (2.5.1). (3) judgments about probabilities and uncertainty. At this point in the risk analysis, a set of event chains have been provided; We call these scenarios. Now we must judge how likely these events are to occur. The most common practice is to assign some probabilities to the expected consequence, but these probabilities alone do not provide an informative risk picture. This is because the probabilities are conditional on certain background information; this background information must be considered when assigning subjective probabilities. (Aven, 2015, p. 42). Aven (2015, p. 25) states that the following conditions represent weak strength of knowledge:

- The assumptions made represent strong simplifications

- Data/information are either non-existence or highly unreliable/irrelevant
- Strong disagreement between experts
- The phenomena involved are poorly understood, models are non-existent or known to give poor predictions

For the knowledge to be considered strong, these following conditions must be met according to (Aven, 2015, p. 26):

- The assumptions made are seen as very reasonable.
- Large amount of reliable and relevant data are available
- There is a broad agreement among experts
- The phenomena involved are well understood; the models used are known to give good predictions.

If there is a case that lands between weak, and strong knowledge, the strength of knowledge is judged as medium.

In some cases, there can be more than one appropriate approach for the analysis method that can be applied. Therefore it is important to consider all plausible alternative analysis approaches and to consider if the chosen approach is selected in a logical process. The decision-makers shall also be consulted on the implications of choosing an alternative analysis approach (Lathrop et al., n.d., p. 15).

2.5.1 Bow tie diagram

A bow tie diagram is combination of cause and consequences analysis. Where the identified causes are on the left side of the diagram, and the consequences are on the right side. As we see in Figure 6, the analysis often consists of several sub-risk analyses. There are different ways one can do this. We see from this example that in addition to the bow tie diagrams, fault tree analysis has been conducted for the initiating event and how barriers can fail (Aven, 2015, p. 40).

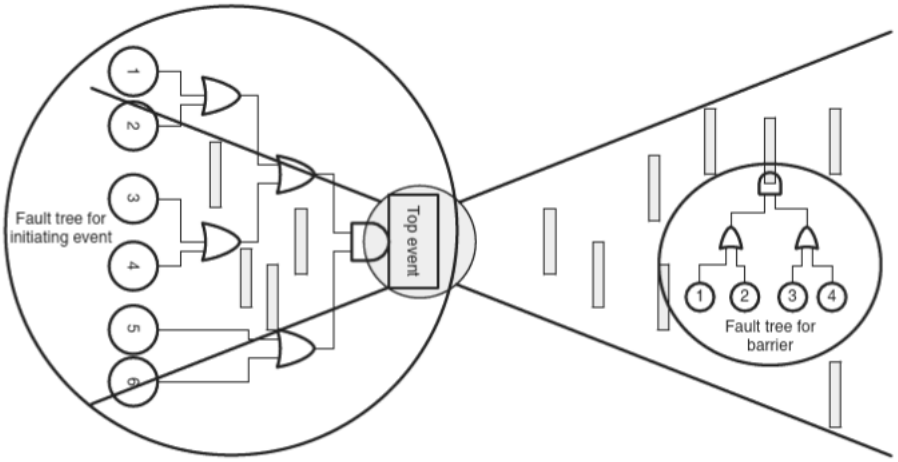

Figure 6 Bow tie, with use of fault trees (Aven, 2015, p. 40)

2.5.2 Coarse risk analysis.

The coarse risk analysis systematic approach is a common method used to establish a risk picture. It gives an overview of the hazards related to an activity and is a simple method that requires little resources to perform. How detailed the coarse analysis is may vary, but Even though it is simple, the coarse risk analysis gives valuable information surrounding the risks (Aven, 1993, p, 68). Its common practice when performing a coarse risk assessment to divide the analysis subject into different sub-elements and then do further analysis for these elements(Aven, 2015, p. 55), as illustrated by the figure below.

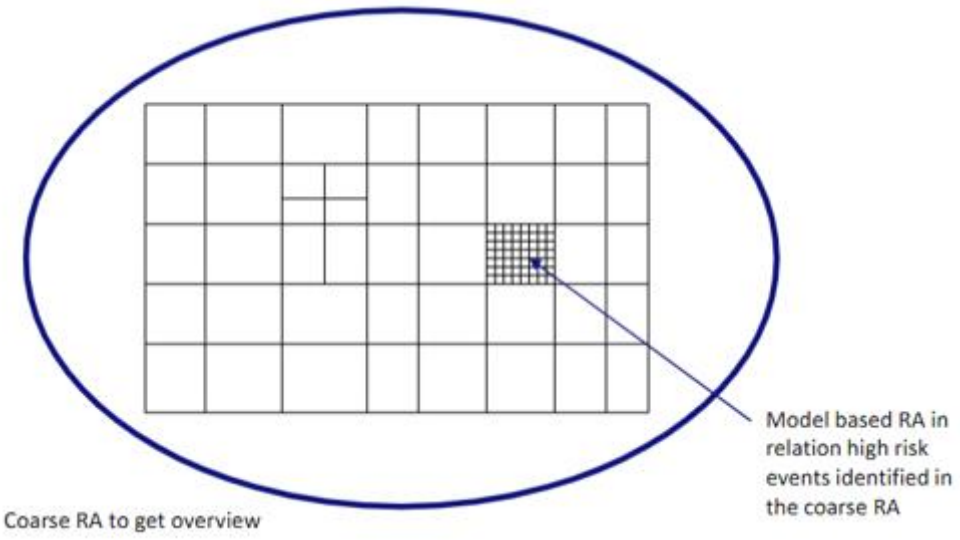

Figure 7 combination of different Risk assessment methods (Aven, 2015, p. 55)

The categories of a coarse risk analysis often consist of probability, consequence, and undesired events. When deciding upon the different consequence categories and probability categories, one should try to stay away from using terms such as “likely” or “unlikely” when assessing the probability and “High” or “low” when assessing the consequences. This is because these types of terms are open to interpretation; however, it is appropriate to use these terms as long as they are precisely described (Aven, 2015, p. 57).

2.5.3 Cost-benefit analysis (CBA)

There are some substantial limitations when using a traditional CBA. All attributes in the CBA must be changed to a monetary value. Already here, we encounter problems; We often analyze the loss of human lives or damage done to the environment. (Abrahamsen et al., 2011, p. 70). How can one person put a monetary value on the life of a human? This, In itself, is a challenge, as there is no correct answer. For most people, it will be infinite. One can accept a risk for a certain amount of money/benefit, which is how Organisations think. The challenge is finding the right balance between the benefit obtained and the value to a human lives. This is a strategic issue and will to a great extent, influence the outcome of a CBA. Different analysts will have different background information dependent on how the decision-makers value a human life. This leads to different analysts giving different outcomes of their analysis, one can come to the conclusion that the E[NPV] is positive, and the other is negative. Because of the difference in the value of human lives (Abrahamsen et al., 2004, p. 352). A traditional CBA is insufficient to determine if an HSE requirement or measure should be implemented. The analysis should only be a tool providing better decision support. Other considerations need to be included in the analysis. The main issue with CBA is the focus on expected values where little to no attention is given to uncertainties. If there is potential for an event with extreme consequences, the use of excepted values can be misleading (Sørskår & Abrahamsen, 2017, p. 4). This is because the Expected values can give poor prediction compared to the actual values (Sørskår & Abrahamsen, 2017, p. 5).

Does this mean it is inappropriate to use CBA? Well, the answer is both yes and no. It depends on the decision-making context. In situations where there are strong knowledge and low uncertainties, CBAs can be appropriate to use as a decision-support tool. By adopting a stronger weight to the cautionary principle in decision contexts like this, it would just lead to inappropriate use of resources (Podofillini et al., 2015, p. 744).

2.6 Risk evaluation

Risk evaluation is the process where we judge the significance of the risk, ranking the priority of the risks and measures with respect to the risks. Decision-makers do not usually take part in the risk evaluation process. This is conducted by the analysis (Aven & Thekdi, 2021, p. 78). When the risk is evaluated, the results from the analysis are compared to risk acceptance criteria to determine if the set criteria are met (Rausand & Haugen, 2020, p. 74).

When evaluating the risk, we also need to think about the knowledge that the analysis is based upon. We need to address the following: What inputs are objective facts? What objective is subjective meanings? Which inputs are based on modeling? Is the knowledge based on argumentation and reasoning? Are there aspects treated with assumptions? Are the analysis broadly accepted, or are they newer and not widely accepted yet? Is the strength of knowledge adequate in its ability to support the decisions? (Lathrop et al., n.d., p. 11).

One also needs to be aware of the possibility that there can be knowledge that has not been taken into account. People outside the analysis group might have knowledge that needed to be taken into account. Using an independent review of the analysis can be a measure to ensure that unconsidered knowledge is being noticed (Lathrop et al., n.d., p. 11).

2.6.1 Evaluating the Strength of knowledge

Uncertainty is a central part of any risk assessment and needs to be addressed. The knowledge that supports the risk characterization should be evaluated in the following six uncertainty sources. All uncertainties should be listed and characterized in one place so that the decision-makers understand. The characterization needs to give clear answers on key elements such as: what is uncertain? Who is uncertain? What are the main sources of uncertainties are, How are the uncertainties represented or expressed? (Lathrop et al., n.d., p 13)

Uncertainty Native to Data

The part of the sampled data that represents the type of uncertainty that is unavoidable and cannot be eliminated is also referred to as aleatory uncertainty. The aleatory uncertainties need to be characterized so the decision-makers understand. The decision-makers must also be informed on how the aleatory uncertainty can escalate and spread, and this escalation should be extensively analyzed with a sensitivity analysis (Lathrop et al., n.d., p. 13).

Uncertainty Due to Limitations of Data Collection

This characterization looks into practical consideration of the amount of data gathered is sufficient for ideal risk management. Should we reduce the uncertainty of the data by allocating more time and resources for data gathering given, that is, if the data are obtainable. The uncertainty must be defined so the decision-makers can understand the characterized uncertainty and limitations of the data gathered and the uncertainty this brings (Lathrop et al., n.d., p. 13).

Uncertainty Arising from Expert judgement

Expert judgments involve uncertainty, and the uncertainty of these judgments can be significant and very hard to characterize (Lathrop et al., n.d., p. 13). Also, here the uncertainty characterization must be defined so the decision-makers understand how these uncertainties can spread, creating more uncertainty in the rest of the risk assessment (Lathrop et al., n.d., p. 14).

Uncertainty arising from Disagreement Among Experts

Special cases of uncertainty can arise when there are conflicting judgments from experts on a topic. We separate these types of uncertainties from the previous mention because the uncertainty is then typically larger for non-experts. Again, the uncertainty characterization must be defined so the decision-makers understand, And how these uncertainties can spread, creating more uncertainty in the rest of the risk assessment (Lathrop et al., n.d., p. 14).

Uncertainty captured by scenarios

These uncertainty sources include failure mode scenarios and alternative model-run scenarios. These scenarios need to be generated with a process that encourages capturing a wide range of scenarios so that more uncertainties are uncovered. Do the generated scenarios undergo a process that thoroughly tests the system interactions. Also, here the uncertainty characterization must be defined so the decision-makers understand, and the implications of the scenario uncertainty (Lathrop et al., n.d., p. 14).

Model uncertainty

Here we address the uncertainty of the model used as a basis for the analysis to assess if the model used captures the complete risk picture. The uncertainty here can arise from disagreements regarding which model best captures the risk picture. Also, here the uncertainty characterization must be defined so the decision-makers understand, and the implications of the model uncertainty (Lathrop et al., n.d., p. 14).

When the uncertainty of these six sources has been evaluated, can it be combined into a presentation of the total uncertainty. These result needs to be presented in a way that is understandable to the decision-makers. Parts that are of particular concern here are the parts that lack explanations of confidence level and results without any support. (Lathrop et al., n.d., p 14).

2.7 Risk treatment

Deciding on how the risk is to be treated is a decision for the decision-makers, but providing decision support for how to treat the risk is a part of the risk assessment process done by the analysts (Rausand & Haugen, 2020, p. 75). Rausand & Haugen (2020) presents three primary principles for risk reduction measures can be used:

1. Prevent initiating event from occurring.
2. Reduce the probability of the initiating event.
3. Reduce the consequences of the initiating event.

The analysis group should also consider other risk treatment options/courses of action. There should be a systematic process with the goal of identifying alternative measures. Often the focus is on one or a small set of different measures. The best way to address the situation is to try creating alternatives other than the one or few being considered. (Lathrop et al., n.d., p. 10)

2.8 Risk picture: presentation of risk

When the risk assessment is finished, it needs to be presented to the decision-makers. The success of the risk assessment in its ability to provide good decision support is primarily based on how well it is presented (Abrahamsen et al., 2014, p. 198). It is important that key terms are defined, and results are explained without using any abstract terms (Lathrop et al., n.d., p. 16). The risk picture is the output of the risk assessment. It should cover the specified event, Probabilities for these various events, consequences of these events, and what knowledge this is based on (Aven, 2015, p. 43). Risk matrices are a common tool to visualize the risk, and when used, they usually present the risk to the decision-makers through probabilities and expected consequences (Abrahamsen et al., 2014, p. 198). Figure 8 shows us what a standard risk matrix includes colors and numbers that indicate the severity of the risk. Green events are low risk, yellow events are medium risk, and red are high risk. The risk is usually placed in the matrix by multiplying the consequence and probability. In the example

below, we can see how this works if the probability of the event to occur is four and the consequence is two, the severity of the risk is judged as eight or High (Kaya, 2018, p, 71).

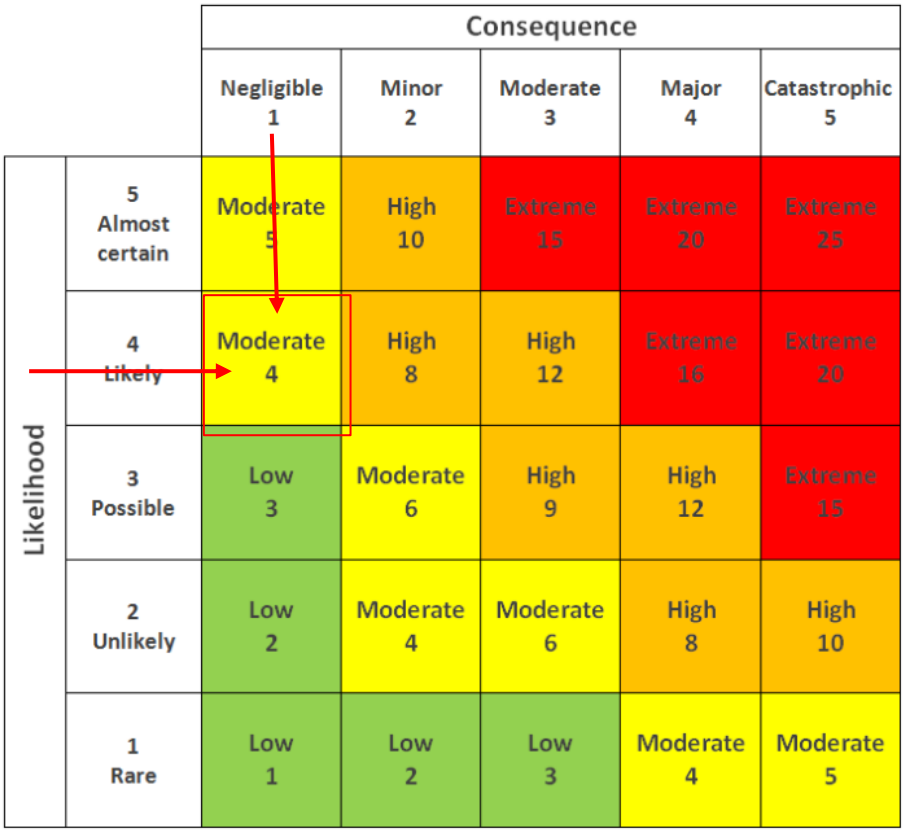

Figure 8 Standard risk matrix (Kaya, 2018 p, 71)

The traditional risk matrix is easy to use and understand, But it does have its limitations. One main issue with the traditional risk matrix is the use of Probability and expected consequences. The problem with this is that uncertainties are not taken into account when presenting the risk. Probability and expected consequences alone do not provide the decision-maker with sufficient information on how to treat the risk.

Secondly, when assessing the risk, we do so subjectively based on our knowledge, meaning that two risk analysist can judge the same risk differently because they have different available information (Aven & Thekdi, 2021, p. 47). Let us say a decision-maker has two different risk assessments in front of him; One analyst judges the risk low, but the other judges it to be high. Without more information, it is a challenging, if not impossible, task to decide whether or not the risk needs to be treated. Because of this, there is a need for the analyst to include in the presentation what their knowledge is based upon (Aven & Thekdi, 2021, p. 371).

Another issue with the traditional risk matrix is that the consequence of a hazardous event often is only visualized through one point in the matrix. This leads to an improper way to visualize the risk; the matrix will then show us an expected consequence if an event were to occur. The problem here is that the probability of the event occurring differs from the probability of that exact consequence being realized (Aven & Thekdi, 2021, p. 47). There needs to be a distinction made between the probability of an event occurring and the probability of different consequences if the event were to occur. Figure 9 shows how we can separate the different consequences with their respective probability from the probability of the event to occur so that instead of only seeing expected consequences, we see different potential consequences (Aven, 2015, p. 45).

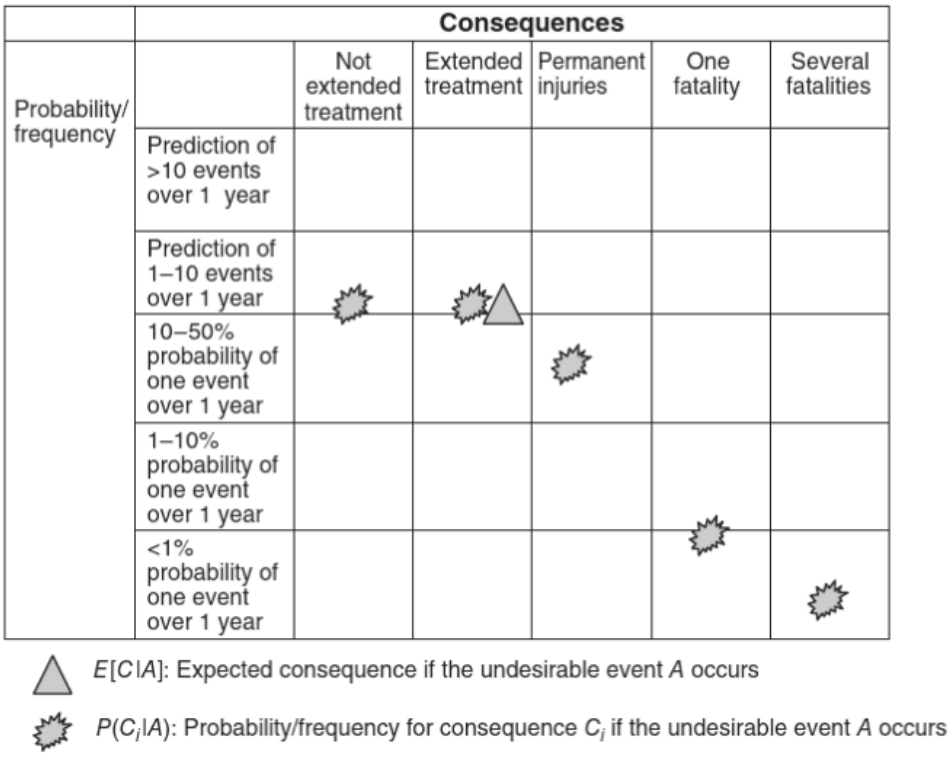

Figure 9 Risk matrix where distinction has been made between probability of event to occur, and probability for potential consequences to occur (Aven, 2015, p. 45)

Lastly, on the use of risk matrices, it is important to have in mind when using matrices as a tool that it is not a tool for analyzing risk; it is a tool for describing and presenting risk. Again we bring back the traditional risk matrix, but this time the focus is on the numbers representing the severity of the risk, where 1 is the lowest risk, and 25 is the highest risk on a 5 x 5 scale (Aven, 2015, p. 143).

		Consequence – number of fatalities					
		Category	≤ 5 1	6–50 2	51–300 3	301–1000 4	>1000 5
Probability	> once per year	5	5	10	15	20	25
	1–3 times per 10 years	4	4			16	20
	1–3 times every 100 years	3	3	6	9	12	15
	1–3 times every 500 years	2	4	4			10
	< once every 500 years	1	1	2	3	4	5

Difference: 4

Difference: 5

Figure 10. Improper way of using the risk matrix, with scores from 1-5 (Aven, 2015, p. 144).

		Consequence – number of fatalities					
		Per year	≤ 5 2.5	6–50 28	51–300 175	301–1000 650	>1000 1.200
Probability	> once per year	2	5	56	350	1300	2400
	1–3 times per 10 years	0.2	0.5			130	240
	1–3 times every 100 years	0.02	0.05	0.56	3.5	13	24
	1–3 times every 500 years	0.004	0.01	0.112			4.8
	< once every 500 years	0.001	0.0025	0.028	0.17	0.65	1.2

Difference: 117

Difference: 3.6

Figure 11 Risk matrix, With scores based on expected number of fatalities (Aven, 2015, p. 144).

In Figure 10, risk-reducing measure 1 reduces the risk severity score by 4 points. Risk-reducing measure 2 brings down the severity score by 5 points. Now let us assume an analysis recommends going with measure two as it brings down the severity with the most points. Now let us see the same example, but instead of using a scale from 1-5, we use a midpoint of the probability and consequence categories that almost follows a Logarithmic scale (almost a 10-fold increase for each category). If the analysis group were to base their recommendation based on the score, the risk severity would go down, it is clear what measure to recommend in Figure 11, but in Figure 10, the difference is so small. In addition, the recommendation is the opposite of Figure 11 (Aven, 2015, p. 145). The point here is that it is essential to notice that the matrix is a tool for visualization, not analysis. If used as an analysis tool, the results will differ from each matrix depending on the analysis tool. Using a scale from 1-5 is OK, as long as it is used only for presentation. (Aven, 2015, p. 145)

2.9 ALARP principle

The ALARP principle is a decision-making strategy that states that risk should be reduced to a level that is "As Low As Reasonably Practicable." Meaning that as long as it can be demonstrated that the costs of the measure are not grossly disproportionate relative to the benefits gained, it should be implemented (Aven, 2011). Different tools and methods can be used to verify ALARP, but how appropriate the implementation of the ALARP principle is in safety management depends on how one interprets ALARP and the grossly disproportionate criterion (Abrahamsen & Abrahamsen, 2015, p. 773).

Using traditional Cost Benefit Analysis (CBA) is one method to implement ALARP. When using CBA in the ALARP principle, a cost can be defined as grossly disproportionate to the benefits obtained if the expected costs are X times higher than the expected benefit. X represents the disproportionate factor and is set by the decision-makers. The value of X can be different depending on what type of decision is made. However, using only CBA to verify the ALARP principle is not appropriate. This is because CBA focuses on expected values and do not take uncertainties into consideration (Abrahamsen & Abrahamsen, 2015, p. 744)

A more appropriate way to implement the ALARP principle is the layered approach (illustrated in Figure 12) which better takes uncertainties into consideration. This approach consists of three steps. In step 1, a crude analysis is conducted; if the costs are low, we implement the measure. If it is concluded in step 1 that the costs are high, we move on to step 2. In step 2, a traditional cost-benefit analysis is done, here we can arrive at the conclusion that the costs are not grossly disproportionate due to the benefits being higher than the costs. Nevertheless, even if the costs are higher than the benefits, we can still implement the measure according to the layered approach; this leads us to the third step. In the third step, a checklist is used for the analysis (Abrahamsen et al., 2018). According to Aven (2011), The checklist should cover aspects such as:

- Are there high uncertainties related to the phenomena, consequences and conditions? and will the measure reduce uncertainty.
- Does the measure significantly increase manageability?
- Personnel with high competence can give increased insurance that satisfactory outcomes will be reached.
- Does the measure contribute to obtaining a more robust solution
- Are the measure based on the best available technology (BAT)?

- Are there any unsolved problem areas: personnel safety-related and/ or work environment? And are there possible areas that conflict in these two aspects.
- Is there a need for strategic considerations?

Depending on these answers, we can make a decision on whether or not to implement the measure. If many of the answers are "yes," there are high levels of uncertainty, and the measure can be implemented because gross disproportion has not been demonstrated. Otherwise, if there are low levels of uncertainty, gross disproportion has been demonstrated, and the measure should not be implemented (Aven, 2011, p. 10).

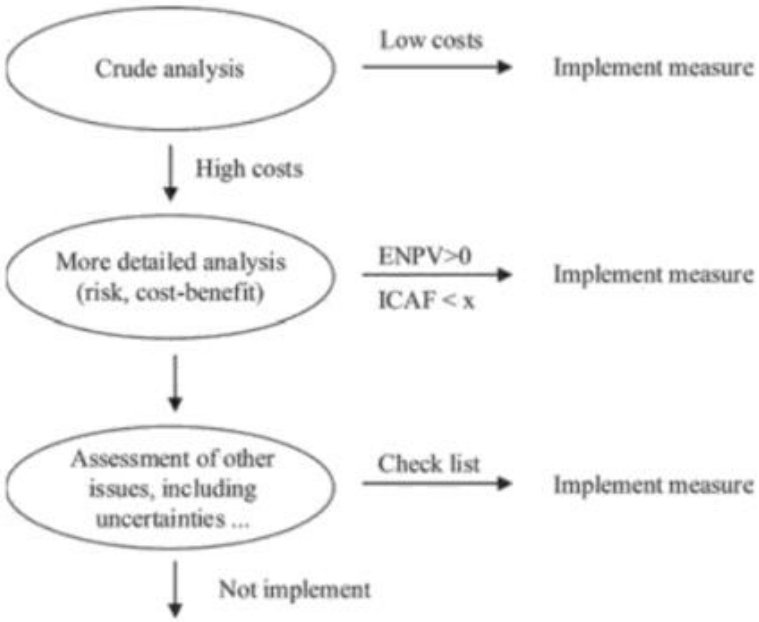

Figure 12 Layered approach (Abrahamsen & Abrahamsen, 2015, p 774)

2.9.1 Uncertainty in safety management.

There are different perspectives when it comes to how much weight should be given to uncertainties when making decisions in relation to safety. One is an extreme economic perspective where one uses CBAs as the tool for decision support. This perspective takes little to zero consideration into uncertainties because decisions are being made based on expected values. Only using expected values as a general decision-making principal is not enough. However, as mentioned earlier in section (2.5.3), it is in some contexts appropriate to use a traditional CBA (Abrahamsen & Abrahamsen, 2015, p. 744).

In contrast to the extreme economic perspective, we have the extreme safety perspective. This perspective gives strong weight to the cautionary principle without any references to CBAs.

This perspective, however, can only be seen as appropriate in situations where there are extreme risks or extreme vulnerabilities. This perspective is not appropriate alone because it is not cost-effective (Abrahamsen & Abrahamsen, 2015, p. 745).

Suppose ALARP is to be the ruling decision-making principle. In that case, it needs to be interpreted in a dynamic way that ranges from one extreme perspective to the other depending on what type of decision is to be made. The most appropriate way to implement ALARP is to adopt the layered approach with a checklist/guideline that contributes to the ALARP's principle ability to move between the two extremes in different decision-making contexts (Abrahamsen & Abrahamsen, 2015, p. 775).

A slightly adjusted version of Figure 12 (figure 13) has been made to make it more transparent that the layered approach can range from one perspective to another. Instead of three steps, it is divided into two, the first step being completely similar to the original figure. The second step is split into two parts; the first one is where the decision context is classified regarding the same issues mentioned in step three of the original figure. The second part of step two shows us what extreme perspective is most appropriate in this decision-making context. (Abrahamsen & Abrahamsen, 2015, p. 775). When all the issues are taken into account, we can either assess the issues as unproblematic (low uncertainty, best available technology is used, etc.) or problematic (high uncertainty, the best technology is not used, etc). What the results are from this assessment decides what perspective to use. For other contexts that do not fall into any of the extreme perspectives, somewhere between the two should be used (Abrahamsen & Abrahamsen, 2015, p. 776).

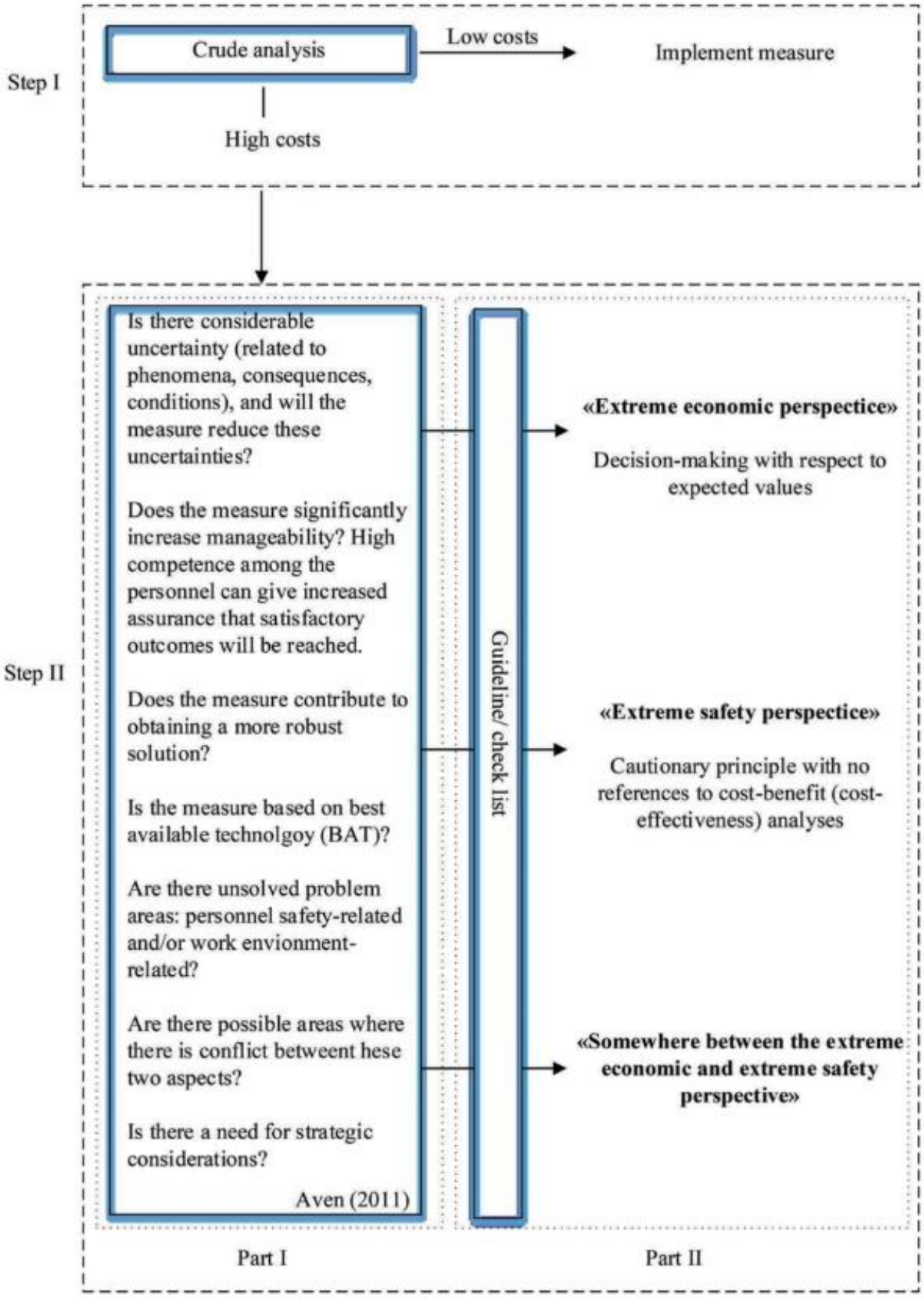

Figure 13 Alternative visualisation of the layered approach (Abrahamsen & Abrahamsen, 2015, p 776)

2.10 Enterprise risk management (ERM) and Task Risk Management (TRM)

We divide risk into three categories: enterprise risk, task risk, and personal risk. Enterprise risk deviations are expressed through the impact dimension defined by the enterprise. For example, change in monetary value and occurrence of incidents (Aven & Thekdi, 2020, p. 46). When we are thinking of deviations for the task, it is not directly expressed through these impact dimensions but could instead be linked to, for example, deviations in relation to project delays. Personal risk is linked to deviations in the form of recognition and compensation. Understanding these types of risks and their differences is essential to understand the incentives behind risk management (Aven & Thekdi, 2020, p. 47).

In the ERM, the focus lies on the enterprise and its principal objectives. In the enterprise, there are a number of different projects being carried out. However, the risks from these projects are not always clear and straightforwardly linked to these impact dimensions. In the TRM, the long-term goal is to contribute to meeting the principal objectives, but as already mentioned, it is not always the case that the TRM goals are linked to the principal objective. The TRM goals may even have a negative impact in some cases. When the TRM aims to satisfy the project goals, it is called goal-induced actions (Aven & Thekdi, 2020, p. 47).

We also need to address personal risk management (PRM). Although it is not a formal part of the management of an enterprise, it could strongly affect the TRM and ERM. For example, can a manager have a goal of increasing his/hers income by 25%. In order to reach this goal, a project must meet a specific task goal. This can significantly influence the manager to reach the TRM goal instead of focusing on ERM goals (Aven & Thekdi, 2020, p. 47).

There is a hierarchy in risk management where ERM is on top and should always overrule PRM and TRM to make sure that the principal objectives always are reached. This conflict between ERM and TRM is not captured in current thinking, and strategic objectives are often set as a desired future state where actions towards meeting these objectives are implemented and measured through key performance indicators (KPIs). This thinking is encouraged by the ISO 31000 standard, as we mentioned in section 2.2.1. (Aven & Thekdi, 2020, p. 48).

In current practice, it is the KPIs that often become the goal itself, and risk management is about increasing the probability of reaching these goals. These goals can have weak to no link to the principal objectives (Aven & Thekdi, 2020, p. 48).

It is crucial that the governing document in an enterprise defines both the ERM and TRM in order to ensure that the ERM overrules the TRM. It is essential that the ERM prioritization rule is clearly formulated. By implementing the ERM overrule property, one can ensure that the challenges of ERM are still addressed even though the ISO perspective is implemented (Aven & Thekdi, 2020, p. 52).

To further illustrate the importance of ERM overruling TRM, we consider a case from the oil industry. In this example, there is an oil company where the strategic objective is to create value. The cost of drilling is set as a KPI, with targets being drilling cost per meter at X. Within TRM, risk-adjusting actions set in place to increase the probability of reaching the cost target will be appreciated. Meanwhile, in ERM, creating value and balancing risk versus rewards will be added. In ERM, a reservoir with a higher drill cost, but in return, it generates a much higher value. If the TRM were to choose, it would go against the strategic objective in order to reach its KPI, but with the overruling principle, the more expensive reservoir would be chosen because it is seen in relation to the ERM (Aven & Thekdi, 2020, p. 55).

3 Method

The word method has its origins in ancient Greece. Back then, the meaning of the word was "the pursuit of knowledge. In more modern times; the word has a broader definition. We define it more as "a way of doing something in accordance with a plan, or a special procedure" (Nola & Sankey, 2014, p. 12). This chapter will present the method used to answer the research question, "How do Hæhre work with risk management, and in what ways can Hæhre improve their risk management practices to enhance workplace safety and strengthen the overall quality of their risk management?". Topics like: the research design of the thesis, Data sources used, the data collection process, techniques used for analysis, Ethical concerns surrounding the thesis, reliability, validity, and limitations of the study will be discussed.

3.1 Research design

There are different methods one can apply when we are researching. Different problem statements require different methods to solve. The methods tell us how we should work in order to acquire or test knowledge. The justification for choosing a method is that we believe it is the best-suited approach for solving the research question (Dalland, 2017, p. 51).

3.1.1 Quantitative or qualitative method

Quantitative

When we are working with Quantitative methods, we are working with data that is given in the form of numbers, answers, or facts that can be measured and calculated statistically. Quantitative data is often referred to as "hard data"(Harboe, 2006, p, 31). Quantitative methods are used to investigate/measure the degree to which phenomena occur. Experiments, observations, and questionnaires are some methods often used in a quantitative method (Blessing et al., 2009, p. 79). Quantitative methods are characterized by being (Dalland, 2017, p. 53):

- *Precise,* Bring out the most exact reflection of the quantitative variation.
- *Broad,* Quantitative methods focus is more on the wider scope, where we gather little information from a large pool of informant's.
- *Average,* gather information about what is common, the representative.

- *Systematic,* applies tools such as surveys with a set of answers or systematic and structured observations.
- *Not in contact with field,* Data gathering happens without any direct contact to the field
- *Pieces,* Data that are gathered are connected to separate phenomena
- *Explanations,* aims to convey explanations
- *Bystander,* The researcher looks into the phenomenon from outside, and works towards being neutral and being distant.
- *Me-it-relationship,* Between the researcher and informant.

Qualitative

Quantitative methods are applied when we want to investigate the nature of phenomena (Blessing et al., 2009). Qualitative methods give the researcher the opportunity to capture data that cannot be measured in numbers (Dalland, 2017, p. 52). Interviews, videos, literature, field observations, and document analysis provide qualitative data (Harboe, 2006, p. s 31). Qualitative methods are characterized by being (Dalland, 2017, p, 53):

- *Sensitive,* Brings out the best depiction of the quantitative variation.
- *Depth,* quantitative methods goes into the depth and gather much information from a small sample of informants.
- *Distinctive,* Highlights unique, and the eventual deviations.
- *Flexible,* unstructured observations and interviews without any form of set answers.
- *In contact with the field,* data gathering happens in direct contact with the field.
- *Wholeness,* the data gathered aims to bring out coherence and wholeness.
- *Understanding,* aims to convey understandings
- *Participant,* The researcher looks into the phenomenon from the inside, and admits influence and participation.
- *Me-you relationship,* Between researcher and informant

Method applied in this thesis

Based on the research question, we are going to look nature of how a phenomenon works. In this study, the phenomenon is risk management in Hæhre. The Research question can be split into two parts. The first one is how Hæhre works with risk management. Because of this, it was essential that I went into depth about Hæhre as an organization to gather information about processes and strategies related to risk management. Most of the data gathered are data

that is hard to quantify and measure in numbers. The second part aims to determine how and where Hæhre can improve its risk management. Therefore, knowledge of the phenomena needed to be conveyed. The nature of the research question and the characteristics of how this should be answered point out that this master thesis applies a qualitative approach. However, as Blessing et al. (2009) Argue. It is a combined method that provides the best picture. Therefore, in addition to gathering data that was impossible to quantify, data that was possible to quantify was also gathered. The thesis is characterized mainly by qualitative methods but includes quantitative aspects.

3.2 Data collection process

For this master thesis, document and archival analysis was the most used method for data collection. An archival analysis is a retrospective collection method. Retrospective methods either rely upon memories or documents to summarise events. The benefits of archival analysis are how suitable it is for most cases and can be used when reflection is needed (Blessing et al., 2009, p. 105). Archival analysis was deemed the most appropriate method due to its ability to gather data on how things are done, which is precisely the goal of the research question for this master thesis.

Other methods like interviews were also considered but judged to be inappropriate to answer the research question. This is because we want to see what is actually being done. The argument for not choosing an interview was that, instead of gathering data on what is done and documented, we would gather data on what employees say they are supposed to do. This can lead to a data sample that could lead to conclusions that would not actually improve risk management because it does not cover the actual processes being done and documented. While interviews were not used, I had dialogues with some key personnel in Hæhre when researching the topic. This was done in order for me, as a researcher, to get a better understanding of the processes when conducting a risk assessment in all stages of a project.

3.3 data Sample

The data sources used for this study are different documents and observations from Landax. In this master thesis, I am looking into how Hæhre manages risk; therefore, it was deemed appropriate that the primary source of information for this master thesis was Hæhre's "holistic risk management" document. The document is a general description of risk management in Hæhre and covers risk management principles, processes for risk management, and risk management on different levels. Therefore it was judged as an essential document to cover in

order to gather data on how risk management in Hæhre is done. The second most used source for data collection was observations in the risk module and documented risks for one specific project. Using these sources to gather information on what is being done was deemed appropriate as they clearly show what is being documented and visualized. In total, 100 risks from one project were analyzed, these are risk related to HSE, environment and quality.

3.4 Data analysis

To analyze the holistic risk management document, key concepts of how Hæhre works with risk were extracted from the document. When analyzing this document, different sections were connected together in order to figure out what is actually being done and how by comparing the risk analyzed with the processes mentioned in the holistic risk management document. Other connections were made based on dialogues and observations during the information gathering.

Based on the documented risks, a form consisting of 7 different criteria was created to analyze the literature in Chapter 2. The purpose of this analysis was to see whether or not Hæhre's documented risk assessment provides an informative risk picture. The following criteria were:

1. *To what degree do the risk assessment cover the causes for the event occur?*
   Criterion 1 were created based on Aven (2015), in section 2.5 it is mentioned that the risk assessment should include cause analyses.
2. *To what degree are consequences covered if the even were to occur?*
   Criterion 2 were created based on Aven (2015), as mentioned in section 2.5 the risk assessment should include an consequence analysis because of the multiple consequences that can occur from one event.
3. *Are the severity of the consequences Judged?*
   For the risk assessment to provide output for what risks meet the acceptable risk level, judgements about the severity of the risk has to made. Therefore this is included as criterion 3.
4. *Are there any uncertainty about different consequences considered?*
   Criterion 4 is closely linked to the reason why criterion 2 were created, Because there can be different consequences for an event, there can also be different uncertainties for each consequence that can occur that should be addressed.
5. *Are judgements about probability and uncertainty for the risk to occur given?*

Criterion 5 were created based on Aven (2015), as mentioned in section 2.5 the risk assessment includes judgements on probabilities and uncertainty.

6. *What analysis method were used and were other methods considered?*
   Criterion 6 were created based on Lathrop et.al (n.d.), where its mention in section 2.5 that it is important to consider other analysis methods.
7. *Does the assessment take strength of knowledge into account?*
   Based on how central the concept of uncertainty is when facing risk, this needs to be addressed. Therefore as we mention in Section 2.5, The strength of knowledge needs to be addressed.

For each risk assessment, every criterion was evaluated on a scale of 1-5, with 1 representing the lowest score and 5 representing the highest. The assigned scores were described as:

1. Criteria is not taken into consideration
2. Criteria is to a small degree taken into consideration
3. Criterion is to a moderate degree taken into consideration
4. Criterion is adequately taken into consideration.
5. Criterion clearly addressed and taken into consideration

In addition to analyzing to what degree the documented risk provides an informative risk picture. An analysis of how the central risk register affected the risk assessment was conducted. This was done by looking into the same 100 risks analyzed, where I looked into the description of the hazard from the central risk register and the description of the project-specific hazard. In addition to looking into the similarities of the description of the risk, I looked into the risk-reducing measures for the risk. Two questions were asked with different scores:

Question 1: How similar are the description of the hazard in central risk register and project specific hazard.

1. No description for the project specific hazard
2. Very similar/copied
3. There are Project specific hazard descriptions, but these are lacking in detail
4. Clearly describes the project specific hazard relevant for the project

Question 2: Are there any specific risk reducing measures tailored for the project? In order for the risk to score high on this question it also needs to include one of the three risk reducing principles mentioned in section 2.7.

1. Only general existing risk reducing measure.
2. Project specific measures are in place, but these are very similar/copied of the general risk reducing measure
3. Unique Project specific measures are in place, but these are lacking in description.
4. Unique project specific measures are in place that adequately describe the measures
5. Unique project specific measures are in place that clearly describes and address the risk reducing measure.

3.5 Ethical and juridical concerns

It is important when performing a study that all Ethical and juridical concerns are accounted for. Unlike other studies, such as surveys or interviews, this research does not gather information on persons. However, while working with the data material, I noticed that some of the screenshots taken from the management system included names of the people that were either responsible or attended the meeting. These names have been censored by blacking out any information that can be tracked down to people. For additional information, I also utilized dialogues with key personnel in Hæhre. However, they are always referred to as “Key personnel,” so there Is no way to know who gave me the information.

However, there were some juridical concerns about what information could be shared in my master's thesis. In order to ensure that there will not be any issues regarding sensitive information being shared, dialogues and feedback from my external supervisor and key personnel in Hæhre have taken place so that the information used in this master thesis does not contain any sensitive information.

3.6 Quality of the research

3.6.1 Reliability

Reliability is about how a study is done and to what extent it is done in order to avoid random error registrations of data to increase the data’s reliability (Fangen & Sellerberg, 2011, p. 82). The most important way to guarantee reliability is to ensure the data-gathering process is planned and carried out in a solid method (Fangen & Sellerberg, 2011, p. 83). Reliability is linked to questions about if a critical assessment of the way the paper is conducted in order to

make it more reliable and trustworthy. The term reliability is often linked to quantitative studies, where one can test the replicability of the study. However, this is not a relevant criterion when with newer perspectives on qualitative studies (Thagaard, 2018, p. 187). New perspectives on how one can strengthen the reliability of their research include:

- Give a detailed description of the research strategy and what is done, so that it is transparent for the reader how the research was conducted and can judge themselves the research process step by step (Thagaard, 2018, p. 188).
- Account for what is primary data. I.e. make the distinction between what is the researchers interpretations and what is the actual objective data gathered (Thagaard, 2018, p. 188)

In short, the reliability of the data can linked to both the method used to gather data, and the quality of the data that the project is based upon (Thagaard, 2018, p. 188).

Throughout the method chapter, topics like research design, data collection process, data sample, and data analysis techniques have all been discussed and argued for. This is done so that there is transparency of how this master thesis came up with the results it did. This way, readers can themselves judge the research process for the thesis.

Most of the data gathered in this thesis is primary data, either through the holistic risk management document or the risk register. However, I need to put an emphasis on the statistical data gathered based on my own subjective meaning of how well I judged the information on the risk assessment to be documented. My own experience and knowledge surrounding the construction industry are limited. If other researchers with more experience were to do the same study as I did, the result would be highly likely to differ based on the researcher's experience. However, as this can be seen as a substantial limitation to the thesis, I would also address the fact that an essential part of the risk assessment is providing an informative picture. So that one of the limitations of this thesis may also be a strength to some degree. This is because an experienced worker might look at the risk assessment and think it provides a good risk picture based on the little available knowledge. However, myself, who might struggle to do so, see that there is room for improvement when documenting risks in terms of how well they actually are informative.

In short, to quickly account for what is primary data, the holistic risk management document is actual objective data, and the statistical data gathered from the risk register comes directly

from the source but has been processed by me. I.e. me, as a researcher, has subjectively judged them.

3.6.2 Validity

When speaking about validity, we are looking into the research results, and how we interpret the data, It is about how valid the researcher's interpretation is. We can strengthen the research validity by emphasizing theoretical transparency, meaning that the validity of the research can be strengthened by supporting our interpretations of a phenomenon by theory (Thagaard, 2018, p. 189). Construct validity, internal validity, and external validity are three common tests used to establish a research's quality (Yin, 2009, p. 40).

Construct validity

In case study research, Construct validity is a challenging concept. This is often because case studies often fail in regard to the development of a measurable set of data. That data is often collected through subjective judgments from the researcher (Yin, 2009, p. 41). This is something that needs to be addressed with regard to the validity of this thesis. Because much of the data sampled is what me, as a researcher, subjectively deemed to be important, one cannot rule out the possibility that there is missing information. One tactic one can use to increase construct validity is through multiple sources of information (Yin, 2009, p. 42). One issue with this tactic is that there are no other sources of information on how Hæhre does things. Unlike other studies that, for example, see a phenomenon on an industry-wide scope, my scope restricted me to only looking at one organization.

However, to ensure that there is no missing data in the data set, I went through it multiple times and ran a pilot study to (1) see how well it would work out gathering data before starting with the actual data gathering. And (2) gain feedback from my supervisors from Hæhre and the University of Stavanger. I realized in the testing stage that there was a possibility for me to skip a criterion when assessing the risk. Therefore I added the risk ID as a nametag for risk judged. This, later on, helped when I saw that out of the 100 risks judged, a few criteria did not have 100 answers. I could then go back into the data set and see what risk was not judged entirely. Delete the incomplete ones and add them again with all criteria. What I cannot guarantee, though, is the possibility of miss-clicks (clicking on the wrong score by accident). And there is no method to 100% ensure that all answers are clicked right, one might argue that I could double check my judgment, but this would not lead to a more accurate data

set. Only a new, slightly altered data set where the reason for the difference being I judged it differently from the last time.

Internal validity

Internal validity is the second test. It is mainly a big concern for explanatory case studies when a researcher tries to explain how and why one event leads to another event. The problem arises when the researcher incorrectly concludes that there is a relationship between the two events (Yin, 2009, p. 43). Secondly, internal validity extends to the broader issue of making inferences. Every time a case involves an event that cannot be directly observed, it involves inferences. Some tactics that can strengthen internal validity are explanation building and addressing rival explanations (Yin, 2009, p. 44).

Throughout the discussion, especially when discussing the use of the ALARP principle, a big concern was the connection between Hæhre's decision-making processes and the use of the ALARP principle. This was because there was no way for me to observe how a decision-making process was done. However, through explaining how I reached the conclusion I did and by now also adding that in terms of rival explanations, there are none, and if there is a rival explanation, Hæhre severely lacks documentation on how to treat risk because it is the documentation and dialogues with key personnel that explains the reasoning for all assumptions made in order to increase internal validity.

External validity

The third test deals with external validity. In external validity, we are looking to determine if the research's findings are generalizable beyond the case study. Critics often state that single cases often provide a poor basis for generalization. However, there is a difference between survey research and case studies. While in survey research, the goal is a statistical generalization, in a case study, the goal is an analytical generalization. In analytical generalizations, the goal is to generalize a particular set of results to some broader theory (Yin, 2009, p. 43). A theory must be tested by replicating the same finding in different likewise studies (Yin, 2009, p. 44).

Since this is a case study of one organization, it is impossible to generalize the statistical findings. Furthermore, my knowledge cannot be tested by replicating the findings because of the thesis's unique scope and research question. However, this study can be a starting point for future research on risk management in the Norwegian construction industry; more on this in section 6.2.

4 Results

This chapter will present the foundations of the study's data. The data presented are from the documents and observations that have been reviewed and looked into in Hæhre's management system. This chapter will present findings from the Holistic risk management document in Hæhre. This general document covers aspects of risk management such as principles, framework, process, and risk management at different levels in the company. Also, to supplement the Holistic risk management document, data from the risk module containing documentation on risks from one specific project has been gathered and analyzed.

4.1 Holistic risk management in Hæhre

4.1.1 Hæhre – Framework for risk management

Uncertainty management is a core process in Hæhre's management system in landax. Landax is an integrated process-oriented management system designed to give satisfactory security for:

- Achievement of goals related to HSE, quality, environment, economic, work environment, and social responsibility.
- Compliance with requirements for targeted and efficient operations
- Reliable management system for reporting and compliance with laws and regulations

An essential part of Hæhre's culture is risk management which embraces all activities on all levels already, from the purchase of materials, signing of agreements, hiring workforce, etc., all the way to how they actually perform the physical work.

Hæhres risk management is based upon ISO 31000:2018. Risk management aims to minimize unwanted events and threats, manage uncertainty, and maximize potential opportunities for the organization. This will contribute so that Hæhres reaches their goals through:

- Identify, measure, monitor and reporting all of the risks that the organization can be exposed to.
- Establish purposeful risk strategies in order to manage risk.
- Establish contingency plans to handle the consequences of the remaining risks.

4.1.2 Principles for risk management in HE

HE has 10 overall principles for risk management, these principles are in accordance to the ISO 31000:2018 standard. These are:

1. Risk management in HE shall bring the organization value, meaning maximising opportunities, and reducing threats. By setting smart KPI's and achieving these and through continuous improvement.
2. Risk management in HE is and integrated part of the organisation, processes, and controls on all levels which is Safety, health and work-environment, quality, environment, social responsibility and economics, progress production-management.
3. Risk management is part of the decision making. Leaders will make better decisions, and minimize the uncertainties and threats when there is god risk management in place.
4. Risk management clearly addresses uncertainty. By following the process for risk management (identify, analyse and evaluate), the owner of the risk is better suited to implement controls, and measures to reduce the probability and/ or the consequence of uncertainty.
5. Risk management is systemic, structured, relevant and timely. There is a methodology in HE for carrying out and documenting risk management and internal control in a unified method in the organization, and risk assessment are documented.
6. Risk management is tailored to Hæhre as an organization. Risk management is a part of assessing Hæhre's stakeholders, context and risk profile. The risk assessment process is an integrated part of HE's management system, and is adjusted to the nature, scope and complexity of the work process.
7. Risk management takes human, and cultural factors into account. Organizing in department and work content for the individual is clearly defined, instructions for who is responsible for management, measurement, and control of the risk is clear from the instructions.
8. Risk management in Hæhre is transparent and including. Hæhre includes stakeholders and decision makers in the risk management process, and involve them in the establishment, and updating of context and when deciding upon risk criteria.
9. Risk management is dynamic, repetitive and responsive. Hæhre reacts to internal and external changes. Meaning that framework, processes and risk management reflects

upon changes in business strategies, management plans, financial disposition and organizational structures.

10. Risk management makes it possible for continuous improvements of the organization.

4.1.3 Risk module

The risk module in the management system (landax) is where Hæhre documents all the relevant risks they face in a risk register. This is the primary tool used by Hæhre for risk assessment. As of right now, there are, in total, 266 risks registered in the central risk register. In the module, there are three main phases in which you can sort the risk depending on what phase the project is in. This is because these types of risks are so different from each other that it was deemed appropriate to separate them. The phases are the early phase, the planning phase, and the production phase. Furthermore, in these 3 phases, you can sort it further into general risks that all projects can encounter or project-specific risks. The project-specific risk can be further divided into different areas in the project. We can also separate the risks depending on what time the project is in. This is often done in regards to the progress plan and is more appropriate in smaller projects with only one area. When an Overall- or project specific-risks in landax is being documented, the following points have to be filled out:

- Description of the activity/event.
- Description of the Hazard
- Description of existing risk reducing measures (these are measures that already exist through routines, checklist and training)
- Judgement for probability and consequences for the relevant risk categories (HSE, quality, environment, reputation, cost, progress) the description of these categories is written bellow in section 4.2.3.
- Description of project specific risk reducing measures (these also include the existing measures e.g. routines, checklist and training)

When the risk is documented in landax, it is placed in the risk module in a central risk register where all risks are being documented. The risk can then be showcased in three different ways. The first one is “list.” This is the simplest form for showing the risks, showing only risk ID, activity, risk category, and risk assessment (probability X consequence). It also shows who is responsible for the risk and what “level” the risk is (project-specific or general). It may also contain information on different areas in the project that the risk is relevant to.

The second way to show the risk is called “detailed.” The detailed method shows us all the same information as the list does but adds a description of the hazard for the risk and also what risk-reducing measures there are both project-specific measures.

The third way to show the risk is through a risk matrix. The risk matrix is on a 5 X 5 grid with green, yellow, and red colors. The risk is automatically put in the matrix when documenting and assessing the risk. If the probability is two and the consequence is 4, the severity of the risk is judged as eight and put in the matrix's yellow zone. The severity of the risk ranges from 1 up to 25, where 1 is the lowest risk, and 25 is the highest risk. To the left of the matrix is a description of the probability, The description of consequences is given under the matrix. We see in Section 4.2.4 an illustration of what Hæhre's risk matrix looks like.

4.1.4 Risk management on different levels

Each project goes through 8 different sub-processes, and each process goes through a decision port that decides if the project moves on to the next sub-process. The decision port ensures that Hæhre is ready to go forward to the subprocess of a project. Each subprocess works with different risks.

Projects risks assessment, operational risk assessments and Safe Job Analysis (SJA)

During the offer phase, an overall risk assessment for HSE- and environmental risks are made based on the construction client’s safety, health, and work-environment plan and the environment plan. This risk assessment will showcase existing measures that are well incorporated into the management system, in addition to measures beyond requirements from laws and the contract.

Hæhre's main principle is to reduce the risk as much as possible through risk assessment, planning, execution of work, routines, instructions, and training of employees. In addition to the overall risk assessment for the project, will the facility manager and operations manager conduct operational risk assessment within their designated areas, with assistance from HSE-manager.

If there are changes in the plans or unforeseen events occur, a Safe Job Analysis (SJA) has to be performed so the safety of the operation can be assessed and measures be implemented. All those who perform the task at hand identify the hazard/hazards and identify solutions to reduce the risk of injury and unwanted environmental effects as much as possible. Each SJA is to be documented electronically in landax.

Measures that remove the risk completely are to be prioritized, ALARP-principle, through Good planning and facilitating that, will minimize the probability of an unwanted event occurring. There is no structured process that describes how Hæhre implements the ALARP principle and on how to interpret the grossly disproportionate criterion. However, through dialogues with my supervisor from Hæhre and other personnel in the organization, I got a better understanding of how they treat risks in the organization. They incorporate the ALARP principle by considering the cost-benefit analysis of reducing risk severity during their risk management discussions. In other words, they weigh the cost of the proposed measures against the benefits they would bring. More on how Hæhre does their cost-benefit analysis will be presented later in section 4.2.5. In the same section, Hæhre's measure hierarchy is introduced. The measure hierarchy is also a part of how Hæhre implements the ALARP principle. We will further discuss this in section 5.2.5.

Before the operation starts, will the project management, in cooperation with the construction client, review the risk register for the main processes to ensure a well-thought-out risk register with measures. This is done to identify, verify, and analyze so that the measures are on an acceptable level. The register is updated throughout the lifetime of the project, to ensure that new risks are captured as they arrive as the project progresses.

4.2 Risk Analysis process in HE

Hæhre's Risk management process is divided into seven steps and is done on strategic, tactical, and operational level.

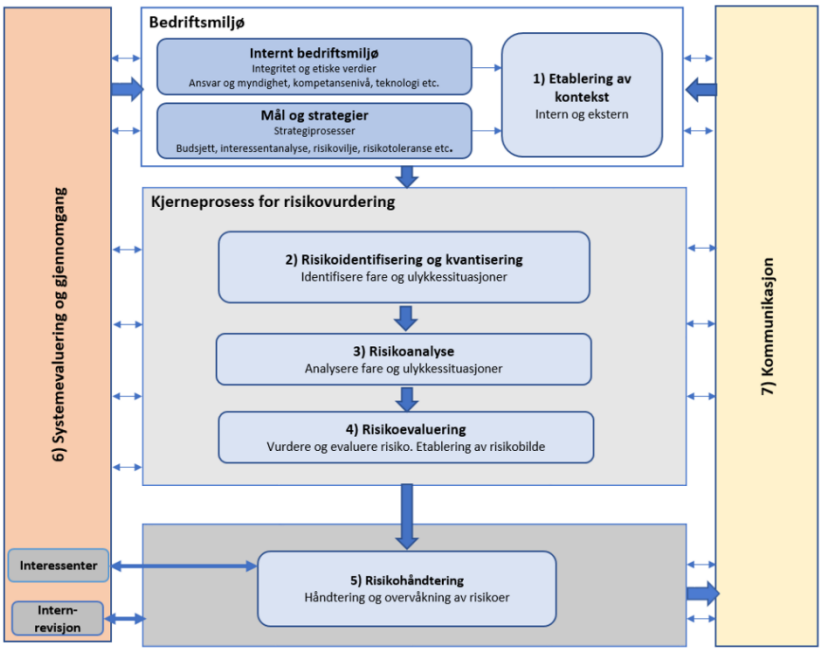

Figure 14 HE risk management process

4.2.1 Step 1 Establish context

Hæhre's context is the organization's framework and guidelines, external and internal, that are significant to the following risk management process. When the context is being established, it is set in relation to laws and regulations, requirements and goals from the construction client, and then Hæhre's own goals and requirements. The context is analyzed in a SWOT analysis to give an overall picture of the organization's strengths, weaknesses, opportunities, and threats in relation to internal and external stakeholders. Stakeholders are to be analyzed with regard to influence and interest in the organization and projects. Tactical and operational risk management is in accordance with Hæhre's context on the strategic level. The context is in accordance with the following:

- HE's goals and vision
- Internal organisational environment factors (HE's ethical enterprise principals, organisation culture and unwritten rules
- Responsibility and organizing

- Competence level
- The organization’s technological solutions

When the context is established the Stakeholders are to be analysed with regards to influence and interest for the organisation and projects. The stakeholder analysis should include:

1. Type of stakeholders.
2. Project specific interest.
3. Categorisation of stakeholder: Core, Primary, secondary.
4. Stakeholders needs.
5. Project’s needs.
6. Risk in relation to stakeholder needs.
7. What type of communication is needed, in relation to influence-interest matrix.

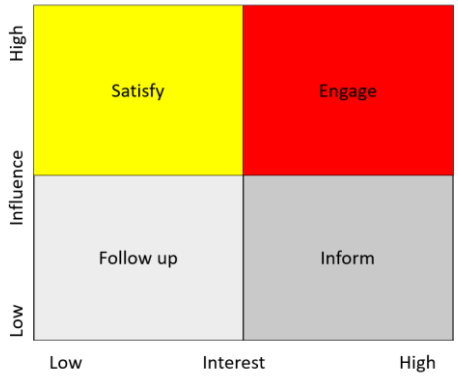

Figure 15 Influence-interest matrix

8. How to handle the stakeholder.
9. What we achieve.

4.2.2 Step 2 Risk identification

Hæhre's risk identification is part of the strategic risk management and is being done on a higher level, and it is adjusted to suit each project and subsidiary company. Identified risks with descriptions of unwanted conditions are documented in different risk assessment tools in Landax. The methods used to identify the risks depend on whether the risks are overall or project specific.

The first method is a review with specialists and experts, Such as reviewing the Constriction-clients Health and Safety Plan for the project. At the start of a new project and the risk

identification process is being done, Hæhre reviews the SHA plan created by the construction client. The SHA plan provides the basis for what risks the project face. An essential step in the risk identification process is to get to know the project well so that risks are linked to conditions relevant to the project. Special areas that require extra attention are also identified in this stage. In these areas, advisors assess the risks Hæhre needs to be aware of when working in these specific areas and needs to take into account when performing their own risk assessment.

The second method is through documented routines, internal and external event statistics, unwanted events, and warnings. One important tool for the second method is the RUE (Registration of Unwanted Events). RUE is where employees in Hæhre can register unwanted events so it documented in the management system, With The RUE Hæhre can identify potentially hazardous conditions and catch up on hazards that regularly occur that there were not aware of before so that risk-reducing measures can be implemented before the hazardous event occurs. Also, Job Safety Analysis (JSA) is an important tool to identify risks for special events and dangerous jobs. First, in Hæhre's JSA, the contexts are established. This is done by documenting what the performing trades/disciplines are, the name of the task, relevant stakeholders, and the equipment being used. The second part is deciding how many sub-tasks are required to fulfil the task. For each sub-task, hazards and threats and identified, and the risk level is judged. Then after the risk is judged, measures are identified; for each measure, one of the involved workers is put as responsible for the measure. Now a new risk level is judged with respect to the risk-reducing measures. When all sub-task is accounted for, all involved participated in the work that is being performed is named.

The third method for the risk identification process is surveys and meetings where they brainstorm the potential risk they may face in a project with a group of people whom all have different the required knowledge to identify all risks.

Risk identification analysis

Figure 16 shows the results from the analysis done when analyzing how similar the risks from the central risk register are to the project-specific risks. The majority (59%) of the risks had no project-specific descriptions, and 26 % were very similar/copied. 8 % of the documented risk has a project-specific description of the hazards. Only 7% of the documented risk clearly described hazards that were relevant to the project.

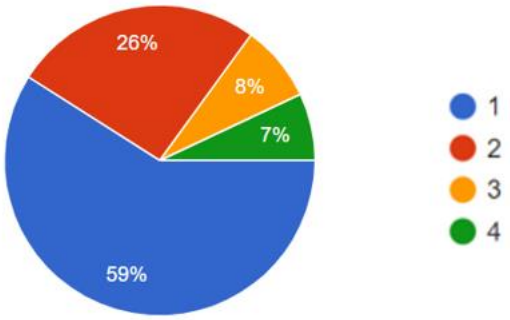

Figure 16 Analysis of the risks identified and their risk descriptions

4.2.3 Step 3 risk assessment

The risk analysis is based on the current situation and efficiency of the organization, subsidiary companies, or project. During the analysis process, an understanding of the risk and risk severity for different activities is made. The severity of the risk is judged by Consequence X probability.

The Consequences of the risk are given based on the expected consequence and are presented in the form of numbers ranging from 1-5. Each number has its own description of the consequences they represent. Uncertainty in Hæhre is expressed through a probability scale ranging from 1 - 5. The probabilities are not given in the form of numbers but rather a qualitative description of how likely they are to occur based on the judgment of the group performing the risk assessment. Through dialogues with employees in Hæhre, it was brought to my attention that the probability given in the risk assessment is a judgment of the likelihood of the consequence to occur, not the actual hazardous event.

In Hæhres management system, support processes and risk assessment tailored for projects and subsidiary companies are the severity of the risk judged by the current established criteria for probability and consequences. Both probability and consequence criteria are judged on a scale from 1 to 5. The probability criteria are described as follows:

1. Unlikely – Not likely to happen, god barriers in place that will hinder an event to occur, Events like this has not happened before in the organisation, but have heard of single cases in the industry.
2. Less likely – Less likely to occur, Have been single cases in the organisation and more cases in the industry.
3. Likely – can occur. Event has occurred on several occasions in the organisation and industry.

4. Most likely – Most likely to occur, regular events that often occur in the organisation and industry.
5. Highly likely, Will occur.

The consequences are divided into 5 different categories each being described on different severity levels under:

Category 1 HSE:

1. Very small – First aid injury
2. Small – personal injury without absence (H2)
3. Moderate – personal injury with absence (H1)
4. High – Serious personal injury with long term disabilities
5. Critical – Loss of human lives

Category 2 Environment:

1. Very small – Smaller emissions/damage that cannot be registered
2. Small – smaller emissions/ moderate damage with restoration time up to 1 month.
3. Moderate – Considerable emissions where measures are needed. Lasting and serious environmental damage. Contaminated land that requires excavation. Restoration time up to 1-3 years.
4. High – Very serious and long lasting environmental damage. Large emission where measures are needed. Local consequences with restoration time up 3-10 years.
5. Critical - Permanent environmental damage. Large uncontrolled emissions, regional and locale consequences with restoration time > 10 years.

Category 3 Reputation:

1. Very small – Small or no consequence for the Company's reputation
2. Small – Limited loss of company's reputation, but does not change the overall positive impression of the company. Local and county media attention.
3. Moderate – Temporary damaged reputation, but no consequence for the progress, Small likelihood for a reduced number of future projects. Regional and county media attention.

4. High -Severely damaged reputation that can give result in less future projects (loss of approval) and / or hinder the company's progress. County/ national media attention.
5. Long term damage or an irreparable reputation that could stop the business. National and international media attention.

Category 4 progress:

1. Very small – No stop in production
2. Small – small production stop, roads are closed in short time periods, good road redirections options. Few consequences for the society.
3. Moderate – Larger production stop, Roads are closed for a longer time period. Local consequences for the society.
4. High – Severe quality deviation, Severe production stop, roads are closed for a extended time period. Long/bad road redirection. Regional consequences for the society.
5. Critical – Severe recovery needed, with severe consequences for the progress of the project. Road is closed for very long time, with long /bad road redirections. National consequences for the society.

Category 5 Economic:

1. Very small – Under 100.000 NOK or 0,1% of the contract price.
2. Small - Over 100.000 NOK or 0,1% of the contract price.
3. Moderate - Over 1 million NOK or 1% of the contract price.
4. High – Over 5 million NOK or 1% of the contract price.
5. Critical – Over 10 mill or 10% of the contract price.

The criteria are clearly defined in the different tools used to analyze and document the risks. How detailed the risk analysis is depends on the risk, the purpose of the analysis, and what information is available. During the analysis, human factors, organizational factors, and technical factors are all taken into account. Human and organizational factors alone are not enough to maintain a barrier and are always combined with at least one of the two others, as shown In the figure below.

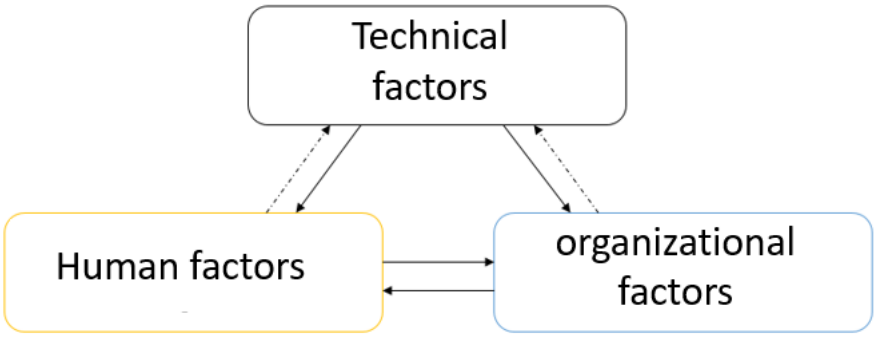

Figure 17 Illustration of Hæhre maintains a barrier

Results from the analysis for the documented risk assessment

In this subchapter, I will present the results from the analysis conducted on the documented risk assessments. As mentioned in the methods chapter, the analysis of the risk assessments is performed by evaluating the assessment based on seven criteria.

I will start with Criteria 1. As we see from Figure 18, the analysis shows us that only 32 % of the risks documented either adequately or clearly address the different causes for the risk to occur. 35 % cover the causes to a moderate degree, 25% cover causes to a limited degree, and 8 % do not cover the cause at all.

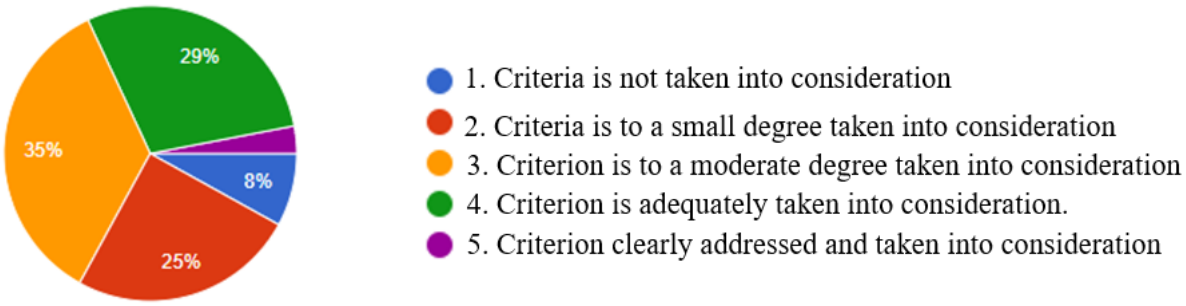

Figure 18 To what degree do the risk assessment cover the causes for the event occur?

The results from Criteria 2 is illustrated in figure 19. We see that 41% of the risks described to a moderate degree the different consequences that could occur if the event were to happen. 35 % of the risks only take the consequences to a small degree into consideration, while 23 % address the consequences adequately. Only 1 % of the documented risk clearly address and take the consequences into consideration. Out of 100 risks analyzed, 0 risks were found that did not take consequences into consideration.

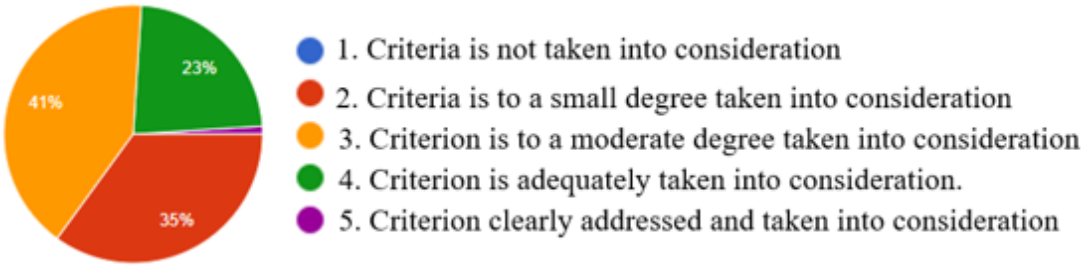

Figure 19 To what degree are the different consequences covered if the event were to occur?

Figure 20 illustrates the results from criteria 3. For criteria 3, the majority (54%) of the risk documented were judged to moderately take the severity of the consequences into consideration. 44% adequately take this into consideration, and 2% take criteria 3 to a small consideration.

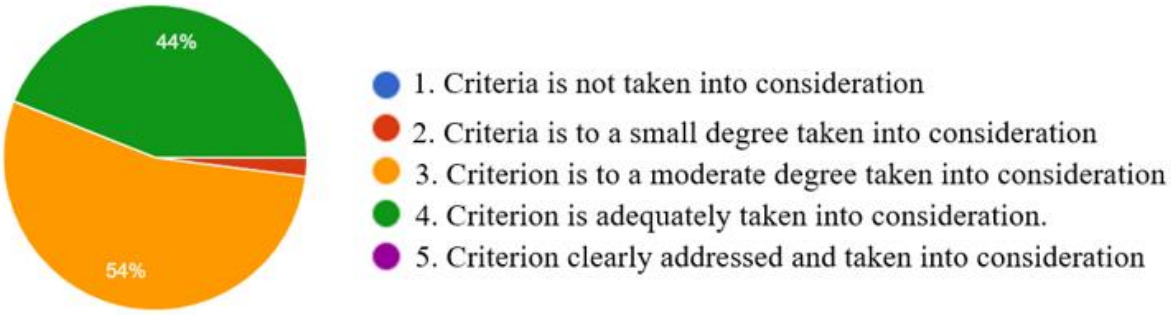

Figure 20 Are the severity of the consequences Judged?

The result from criteria four is illustrated in Figure 21. 60% of the cases studied do not take any consideration into consequences and their associated uncertainties. 38% take to a small degree, consequences and their associated uncertainties into account. Only 2% take this criterion into moderate consideration. 0 % take this adequately or are clearly addressed.

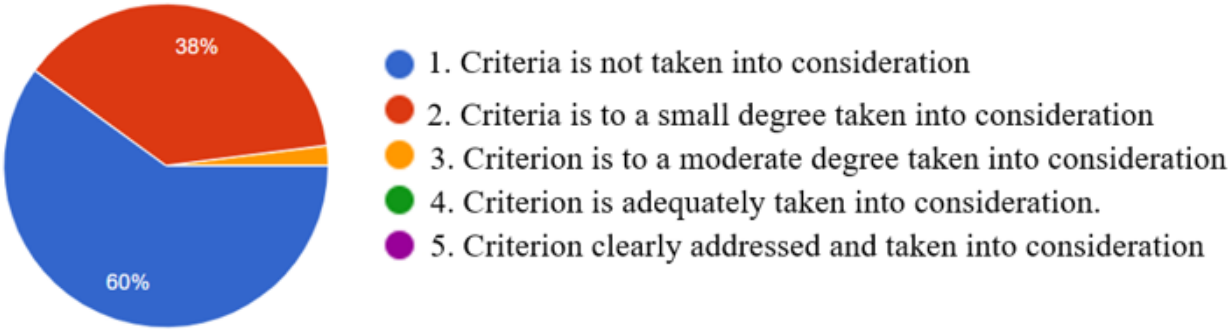

Figure 21 Are there any uncertainty about different consequences considered?

As seen in Figure 22, all 100 risks judged take probability and uncertainty (criteria 5) into account to a moderate degree. Figure 23 shows us that in all cases, there was no documentation on what analysis methods were used or if other analyses were considered to use (Criteria 6).

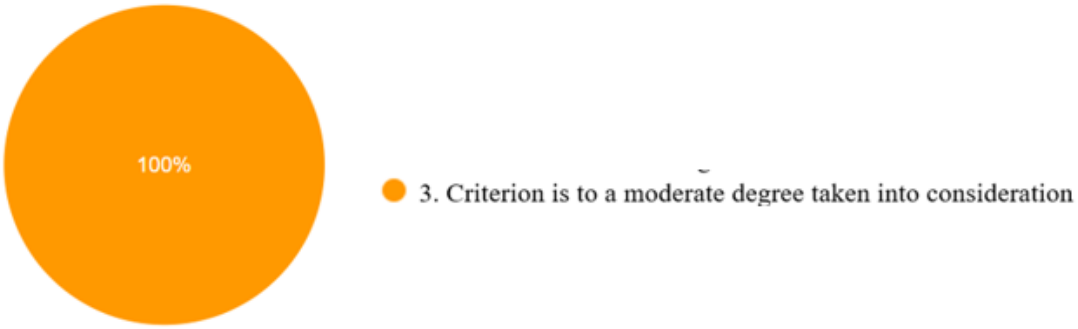

Figure 22 Are judgements about probability and uncertainty for the risk to occur given?

Figure 23 What analysis method were used and were other methods considered?

Figure 24 Shows us the last criteria for the analysis of the risk assessment. Here we can see that in 51% of the cases, SoK were not taken into consideration, 30% took to a small degree

SoK into consideration, and in most of these cases, they referred to some meeting done without any further explanations. The rest of the documented risk takes 8 % moderately into account. 7% adequately, and only 4% clearly addressed SoK.

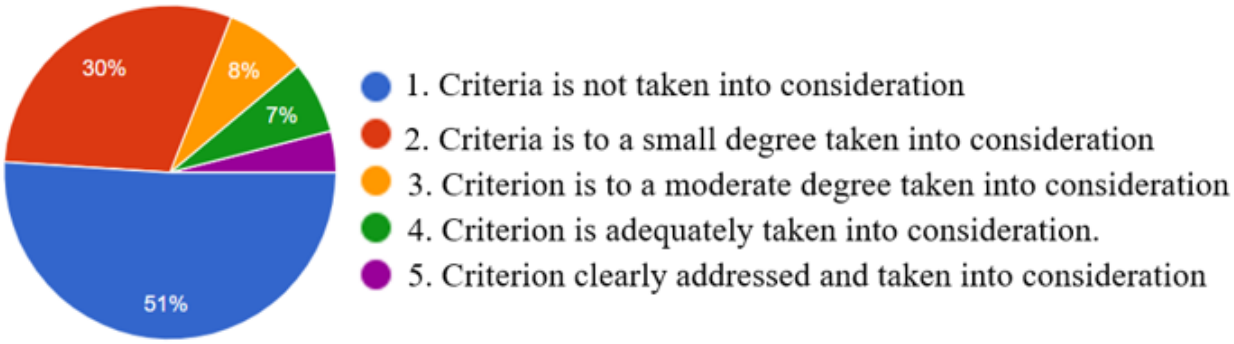

Figure 24 Does the assessment take strength of knowledge into account?

4.2.4 Step 4 Risk evaluation

When the risk is analyzed, it is compared to the risk acceptance criteria that were set during the establishment and assessment of the organization's context. Depending on the results from the evaluation, decisions can be made to do further analysis or handle the risk by maintaining decided control measures. The risks are evaluated by the combination of consequence and possibility. This gives the risk a score from 1 to 25, as shown in Figure 25. Risks that get a score of 15 and above (red colour) are deemed unacceptable measures are required. Yellow (5-12 risk score) are moderate risk where measures are necessary for the risk. Risks that are evaluated with a risk score from 1-4 (green colour) are deemed an acceptable risk.

Figure 25 Hæhre's risk matrix example

4.2.5 Step 5 Risk treatment

Risk treatment in HE's is done on a management level, in projects and subsidiary companies. The risk treatment involves:

- Balancing costs from implementing the measures up against benefits from the measures (Cost-benefit-analysis). However the cost benefit analysis done in Hæhre is not done in the traditional way where one transform all aspects into monetary values. It's done more qualitative method where a group of experts with relevant competence, discuss the benefit of the measure up against the cost without transforming the benefit to monetary values. It's through these discussion that decide whether or not a risk treatment measure is to be implemented or not. A Cost-benefit-Assessment is more appropriate term to use.
  - Prioritize measures, Measures are to follow a "measure hierarchy" that follows:

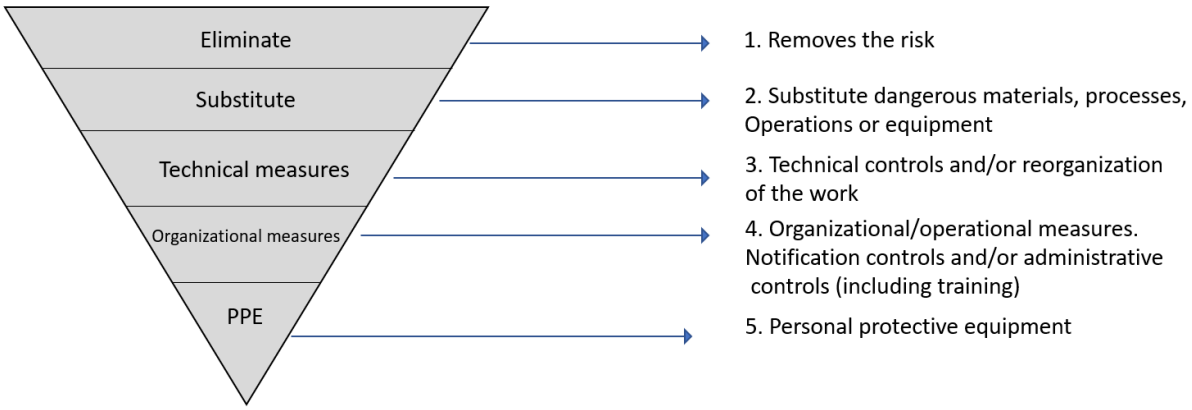

Figure 26 Hæhre's measure hierarchy

- Define action-plan
  - Implement measures in routines and forms. HSE-, quality-, and environment-plans
  - Action-plan in meeting-minutes.
- Monitor measures. Documented risk assessment and uncertainty analysis are updated if need be, and at least one time each year.

Figure 27 illustrates the results from the analysis of the risk-reducing measures. The analysis shows that 40% of the documented risks clearly address project-specific measures. 9 % adequately addresses projects specific measures and 17% has project-specific measures, but these are lacking in detail. 33 % of the documented risk do not have any project-specific risk, only using the general risk-reducing measures. 1% of the risks has copied / very similar project-specific risk.

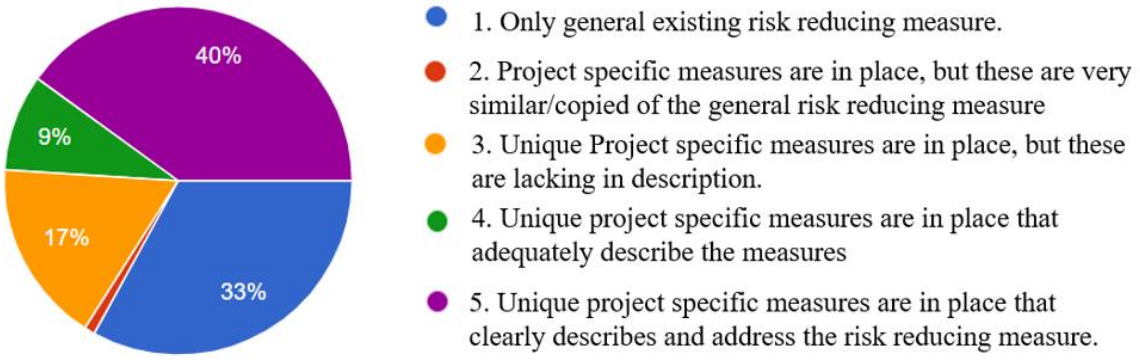

Figure 27 Analysis of risk reducing measures

5 Discussion

5.1 Hæhre's perspective on risk

We will look more closely into the risk and its different perspectives to start the discussion. In principle four, the Holistic risk management document states that "Risk management clearly addresses uncertainty. By following the process for risk management (identify, analyze, and evaluate), the owner of the risk is better suited to implement controls and measures to reduce the probability and/ or the consequence of uncertainty.". This shows us a direct link between ISO 31000:2018 definition of risk "The effect of uncertainty on objectives" and how Hæhre's perspective on risk. This leads to the next question: How does Hæhre's risk management address uncertainty? Is the uncertainty actually taken into consideration when assessing risks? Even though the principle says that it clearly addresses risks, it is hard to understand where it does so. There is, as far as documents go, no clear definition or instructions on how to address uncertainty. Only 19% of the documented risk takes uncertainty into moderately or stronger account by addressing the knowledge that the risk assessment is based on. The majority of the documented risk does not address what the knowledge of the assessment is based on. This may be an effect of the poor guidance mentioned in section 2.2.1, where the ISO 31000 Standard fails to provide a conceptualization of uncertainty and how to measure and describe risk and uncertainty. To further add to the evidence that risk management does not address uncertainty as much as it is supposed to, we can look at how the risks are being measured in the risk module and in section (step 3 Risk assessment) where it clearly shows us that risk is a combination of probability and consequence. In reality, the data shows us that Hæhre's perception of risk is more in the classical line of probability times consequence.

So then, how can this be done differently? In terms of Hæhre's perspective on risk, it is clear that there is a need to update the holistic risk management document with a clear definition of risk and uncertainty and how to measure this. There are multiple ways one can do this, But there should be some key factors, like the ones mentioned in 2.5, the definition should capture: 1. Consequence, 2. Event/activity, and 3. uncertainty. This leaves us with three definitions of risk:

1. risk is the consequences of the activity and associated uncertainties
2. risk is uncertainty about and severity of the consequences of an activity with respect to something that humans value.

3. Risk is the occurrences of some specified consequences of the activity and associated uncertainties

Narrowing down to three definitions was the easy part, but there should be one. A clear definition across the entire organization to avoid confusion if there is more than one. How do we choose then? The three definitions above seem to be the same or have minimal differences. All take into account activity, consequence, and uncertainty. We need to look more closely at each definition in order to figure this out. We can start by ruling out definition number 2. This is because, in this definition, uncertainty only talks about uncertainty related to the severity of the consequences. There are other elements that can be uncertain that are not being addressed, such as the likelihood of the event occurring. Now we are left with 1 and 3, and these two are very similar; however, definition number 3 has something definition one does not; The ability to specify the consequences. Being able to specify the different consequences will make the risk assessment more clear. Therefore, I recommend applying definition number 3 to the holistic risk management document.

Unlike deciding upon a clear common definition of risk, deciding how to measure and describe the risk is different. As mentioned in 2.1, one cannot decide upon one method to apply to all situations because each risk is different from one another. Therefore instructions on how to measure risk in different situations should be implemented. For example, in well-known situations, expected consequences can provide an informative picture. However, a more detailed measure that captures other elements, such as uncertainty, should be implemented in unfamiliar situations; For example, the triplet of (C',Q,K).

5.2 Basing the risk management on ISO 31000, pros and cons

We can start this section by reviewing the positive sides of ISO 31000, where there is no scientific conflict. First, the need for a structured process on how to use risk assessment in risk management. The ISO standard provides users with a clear, structured process on how to do a risk assessment. Hæhre has adopted this process.

The second part is the importance of leadership and commitment in risk management, where there is no scientific conflict. However, this is not clearly included in the holistic risk management document. In The Standard, this is something that is clearly addressed with its own section. However, we do find that if we look for specific points from the leadership and commitment section in the standard, some of these are in place in Hæhre's risk management, just not described as its own part in the holistic risk management do. For example, each

different risk is assigned to one responsible person for that risk. In the central risk register HSE risks are assigned do the HSE manager, Quality risks are assigned to the Head of quality. For project-specific risks, we see that the person responsible for the risk is the construction manager. We can “see” this in appendix 1.2; the censored part is where the people assigned as responsible are listed. In addition, seeing who is responsible for the risks, we also see who is assigned as responsible and making sure different routines are maintained.

In section 2.2.1, we talked about how the ISO standard defines risk and the problems associated with this, but there are more issues regarding the standard's take on risk and uncertainty. The standard characterizes uncertainty through likelihood (probability). We can see clear signs in Hæhre's risk management that this characterization of uncertainty has then also been adopted by Hæhre. We see from both the holistic risk management document and the documented risks that the severity of risk is judged by consequence X probability. Hæhre's holistic risk management document lacks any explanations of key terms like uncertainty, knowledge, and information. This is also most likely a result of the ISO standard failure to address these terms. Hæhre should implement definitions of key terms mentioned above and how to characterize uncertainty into their holistic risk management document. This can be done by addressing the knowledge and SoK when expressing probabilities in their risk assessments. In return, this will lead to more robust risk assessments that address uncertainty.

Hæhre's first principle states, "1. Risk management in HE shall bring the organization value, maximizing opportunities, and reducing threats. By setting smart KPIs and achieving these and through continuous improvement". Again is this something clearly influenced by the standard, the issue with this is that a compliance regime can occur. And judging by principle 1, one might argue that it already has. I will not use much time discussing this as it is such a large field on its own that it can be a different thesis, but I will mention it because it somewhat falls in the scope of this thesis by looking at Hæhre's principles. Therefore I think it is important to discuss this point shortly so that Hæhre is at least aware of the problem that arises when having a compliance regime.

In section 2.10, The importance of having an ERM overruling principle in the governing risk document was mentioned. This is something that Hæhre is missing from their Holistic risk management document. It would be beneficial for Hæhre to add a section in this document where they describe ERM, TRM, and PRM and how they interact with each other. The most important to add to this is the overruling principle of ERM so that even a risk management system based on ISO: 31000 addresses the challenges of a compliance regime, and ERM is

taken into account. If this is not taken into consideration, a system where goals with weak or no link to the principal objective leading to sub-par decisions can, if not already, occur.

5.3 The risk analysis process

5.3.1 Step 1 Establish context

In the planning process, Hæhre states that the context is established in relation to requirements and goals from the construction client and then Hæhre's own goals and requirements. However, when viewing the risk assessment, the goals and purpose of the risk assessment are not added to the risk assessment. Now it should be noted that the analyzed risk are so-called residual risks, meaning that the risk is a risk they have to face when performing the work, or else they would not be able to do the risk. It where found, however, in a separate document, appendix 3. that demonstrates operational risk assessments that "the risk assessment shall be updated and brought down to an acceptable level." So it can be reasonable to say that the goal of these types of risk assessments is to bring the risk down to an acceptable level where the residual risk is acceptable, and the work procedures can be done safely. In terms of goals in the established context, it can be hard for parties outside of Hæhre to truly know what the purpose of the risk assessment is, as there is no information given about what the goals are except to reduce the risk level down to an acceptable level. It is difficult to conclude how this can be better. Adding the goals in these types of risk assessments would just be redundant. As it may be self-explanatory that the goal of these types of risk assessments is to bring the risk to an acceptable level. One simple thing to consider is adding information on what the goal of the residual risk assessment is into the holistic risk management document.

5.3.2 Step 2 Risk identification

Hæhre's risk identification processes could be done in 3 different ways, depending on overall or project-specific risks. The different methods used were specialist review, databases and tools (RUE and JSA), and brainstorming. Establishing a risk register for a new project can quickly become a routine job, Especially when the risk identification is done with databases like Hæhre's risk register. When using databases to identify risks, one needs to be careful not to just copy and paste the risk from previous projects to new ones, even though they might be similar. The new project can have certain aspects that were not relevant in the previous risk analysis. As shown in Figure 16, most of Hæhre's project-specific risks do not include any information on project-specific details. It should be mentioned that just because most of the assessed risks do not include a project-specific description of the hazard, this is something

that necessarily is being done wrong. Some of them may simply not need any more information. Nevertheless, when the result from the analysis showed that as many as 85% of the documented risk that was analyzed either had no description or only copied the risk description from the central risk register. The possibility of there being documented risks that missed out on certain aspects that are relevant for the project is high.

In appendix 1.1, we see a typical example of the description of the risks just being copied over. One typical feature in many cases that should be addressed is where it stands (translated to English) “Discussed in a meeting.” Since one of the most common ways of identifying risks in Hæhre is through creative brainstorming processes, it may be that the project-specific hazards related to the risk were brought to attention during one of these meetings. But the question then arises, why is this not documented? If these hazards are known, they should be documented in the risk assessment, not only discussed in a meeting, so that people who did not attend the meeting have access to the information. It would be optimal if the risk description from the central risk register were still there as a part of the risk assessment, but in addition, information on specific aspects should be added to the risk assessment.

I need to point out that using a database as a risk identification tool is not an issue, and it is a valuable source of information. The issue arises when the risks are just being copied over without any concerns for the unique aspect each separated project might have.

As mentioned in section 2.4.1, the risk identification should be a creative brainstorming process with a structured systematic method to capture both familiar and unfamiliar events. Hæhre uses brainstorming as one of their methods when identifying risks but lacks any documentation on how to do this procedure. Two methods were presented in section 2.4.1, the first one being the checklist method. However, this one has some strong limitations linked to it: limited to previous experience and does not encourage brainstorming. The second one was the SWIFT technique. This is a method that encourages a structured brainstorming process that is both easy to do and document. But again, it has its limitations: it is not foolproof, and risk can be overlooked depending on the experience and knowledge of the team conducting the risk identification. But it is my belief that with a combination of these two Hæhre will able to have an easy-to-do, easy-to-document structured process on how to identify risks. We talked about how 20 % of the time goes to identify 80 % of the risks. This is where the checklist method comes into the picture. When doing the checklist method, it is crucial that this does not lead to copy-pasting. Aspects for the specific project still need to be considered. For the remaining 20 % of the risk, we use 80 % of the time conducting the SWIFT method.

We also mention the job safety analysis method for identifying risks. This method is currently used by Hæhre at all projects before non-routine and/or dangerous jobs are performed. In relation to the literature, Hæhre's process for a JSA is simple and in line with the processes from Figure 4. But it should be addressed that if the analysis is not structured, it can be superficial. We need to continuously ask ourselves if there are any more tasks and hazards related to the job being performed.

5.3.3 Step 3 Risk assessment

The risk Assessment aims to present an informative picture of the risk. The risk assessment should include: cause analysis, consequence analysis, and probability and uncertainty. We see from section 4.1.3 and appendix 1.1 what Hæhre's risk assessment includes: Scenario (Cause analysis) in the form of the activity's name and a description of associated dangers. However, as we see from the results in Figure 18, these cause analyses can vary in the degree of how detailed they are in explaining the initiating events for the risk. Almost one-third of the documented risk adequately covers the initiating events, and one-third barely cover it/ not cover it at all. One reason for the large difference in how detailed the cause analysis was can be because of the lack of a systematic process on how to conduct a risk assessment and what the different areas of the risk assessment should include. For example, there is no clear description of what the field with "description of danger" should include. It is only stated in the holistic risk management that "during the risk assessment process, an understanding of the risk and risk severity for different activities is made.". The holistic risk management document lacks guidance for what the risk assessment should include, leading to different analyses from different persons because there is no organizational guidance. This issue may have risen from the poor guidance of the ISO 31000 standard. To make the risk assessment better, Hæhre should implement in their holistic risk management document what the risk assessment should include. These are factors such as cause analysis, which identifies all initiating events; consequence analysis which identifies all unique consequences; and lastly, judgments about probabilities and uncertainties. One simple method to summarize the cause and consequence when the assessment can be done with a bow tie diagram.

The second discussion point in the risk assessment process is the use of probabilities in relation to the consequences. The way it is done in current practice, we get a risk picture that presents probability X expected consequences. From Figure 21, we can see that uncertainty of the consequence to occur was always judged the same, meaning that all 100 risk assessments covered judgments about uncertainty and probability to a moderate degree. The reason for this

is because it was always being done in the same way. This method can be appropriate for well-known situations, but in situations with larger uncertainties, other ways to measure the probability for something to occur should be adopted.

As we mentioned in section 2.5, the issue with this is that the scenario has many different consequences, with each consequence having a different probability of being the actual consequence that occurs. A “good” example to show the current practice makes this mistake is in appendix 1.2. If we look at the description of the risk, which translates to “Large or small spillage from oil/diesel tank,” Is given the same probability and consequences, it cannot be justified that the consequences of a large spillage are judged to have the same level of risk as small spillage. This demonstrates the importance of separating the probability of an event occurring from the probability of consequences occurring. Figure 19 shows us that this issue affects many of the documented risks. Only 23 % adequately cover different consequences, while only 1 % clearly address this. Most of the documented risks were given three or lower. This is because many of the documented risks do not describe the consequences in words. Usually, the consequences were described through the categories described in section 4.2.3. In order for the assessment to provide a more informative risk picture, The consequences should be described both qualitatively with words and quantitative like the categories mentioned.

To further elaborate on the issue mentioned in the previous paragraph, the assessment of consequences often falls short by focusing on a single category and disregarding other potential impacts. Specifically, only 44% of the evaluated risk assessment adequately cover criterion 3, which is mainly due to their recognition that risks can have an impact across multiple categories. However, none of the documented risks received a rating of 5 (clearly address the criterion). Achieving a score of 5 would require acknowledging not only diverse consequences across various categories but also encompassing a wide range of consequences within the same category.

We see from appendix 1.2.1 that different consequences have been separated for the same event, large and small spillage have each been given separate probability and consequence, which is good, but I still believe there is a better and more effective way to do so.

As of right now, in order to separate the different consequences for an event, you have to register the same risk for each different consequence in the management system. Doing so takes up a lot of time and resources and can quickly “overcrowd the risk register,” as we see in appendix 1.2, where there are 10 risks registered separately because. Therefore I believe

that it can be helpful to update the system where one can register all consequences related to the event in the same risk, where each is given their own judgment on probability and consequences. This will to a greater extent, provide a more informative risk picture and make it easier for the analysist to register relevant risks in the project without there being "too many" overcrowding the register, as we see in appendix 1.2. note that this is because it is connected to different areas of the project, which all have different probabilities and consequences. Nevertheless, the argument for an updated system still stands. I recommend a new updated system where we start with an assessment of the expected consequence if the event were to occur. Then click on that risk to see an assessment for an expected consequence if the event occurs in the different areas the risks are relevant for. Lastly, click on the risk for the specific area; this will take you to a new screen that showcases the different consequences with the respective probability for each consequence. Figure 28 illustrates the process for the new system.

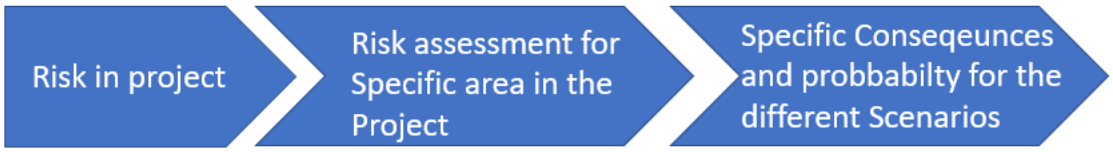

Figure 28 New system for risk assessment in the project

I have already discussed how Hæhre can measure uncertainty, where I concluded that there is not one method that is suited for all situations. However, it should be added that SoK is useful in most situations to provide a better risk picture. The risks in the project-specific risk register are often well-familiar risks. This may be why, as we see in Figure 24, where the majority of the documented risk assessment does not take SoK into consideration at all, and 30 % only addresses this to a small degree which is very limited. The risk that was judged to cover SoK criteria on scale two was done so because they referred to meetings where the risks were discussed. But there was not any more information about the SoK. The risk assessment was judged based on the quality of information they added in the text boxes. Appendix 2 is an example of one of the few documented risks that scored high on this criterion. This is because it describes in detail all information sources that the assessment is based on.

So the question is, should we bother with adding judgment about knowledge? Section 2.6.1 covers many aspects of evaluating uncertainty. Using all these aspects when judging the uncertainty for these types of risks would be too time-consuming and only lead to

inappropriate use of resources. However, a simpler version, like a checklist with the points mentioned in section 2.5, can be appropriate to adopt. This will give the risk assessment more information on what the knowledge is based upon without using more resources necessary for these types of well-known risk.

5.3.4 Step 4 Risk evaluation

The way Hæhre evaluates the risk is through the traditional consequence and probability with a risk score from 1-25. These risks are put into risk matrices to illustrate the severity of the risks. The positive side of using risk matrices is that it is easy to understand and can be applied in most cases. But there are some severe limitations to the traditional risk matrices. Firstly it does not capture uncertainty and SoK, so alone, it is hard to make an informed decision based on the risk matrix. Even though 51% of risks analyzed did not include any information about the knowledge supporting the assessment, there are still 49 % with varying degrees that did include this but is newer shown through Hæhre's risk matrix.

In Hæhre's risk assessment, the probability is given based on the likelihood of the consequence to occur. This becomes an issue later on in the risk analysis. It is confusing, especially in the risk matrix, to know what we are talking about when giving the risk a probability. The risk is given a name based on the activity. This is what is being read first. We immediately connect the name of the risk to the probability and then think about the probability is given for the event to occur, while in reality, the probability is given for the expected consequence to occur. The consequence is illustrated in the risk matrix; that is not the issue. The issue is that it is unclear what the probability refers to, consequence, or event?

We previously discussed that in the current management system impossible to separate the different probabilities for different consequences and events unless the risk is registered more than one time. Since the risk matrix is automatically updated when a new risk is registered, this problem also gets transferred to the risk matrix. In the same section, I also came up with a recommendation for a new system that can improve this. In the same way, the old system works by automatically adding the new risk assessment to the matrix. The new system can also do this by adding three different matrixes. The first one being the expected consequence for the project, the second being the expected consequence for the specific areas, and the last matrix shows the different consequences, each with its own probability. In addition to adding these more specific risk matrixes, the new matrices should also include judgments about SoK to make it even better in presenting an informative risk picture.

It should also be discussed the way Hæhre uses its risk matrix. Although the risk matrix is not the tool used for assessing the risk, One might still argue that it is. This is because the way the current risk matrix is designed so that it completely follows the same numbers that the risk assessment does, and the risk level is what decides what risk gets treated. Let us separate the risk assessment from the risk matrix to clarify my point. Let us say that two persons are analyzing the same risk. One person only uses numbers and judges the probability of the risk to be five and the consequence to be four, meaning that the severity of the risk is judged to be 20. The second person uses a risk matrix to analyze the risk. The judgment about probability and consequences are the same, so the severity of the risk is also 20. Both of them judge the risk to be too high and implement measures. My point here is that even though the risk analysis is not done in the risk matrix, one would still get the same result if it were. So one needs to be careful when using the risk matrix in Hæhre. However, the risk matrix in Hæhre illustrates the risk level. It is the risk level that decides what risk gets treated, not the difference from the old risk level to the new after the risk has been treated, which means that the current purpose of Hæhre risk matrix is OK as long as they do not use the same risk matrix to decide between two different risks that need to be treated. If they, however decide to do so in the future, they need to be aware of the points discussed in this paragraph.

5.3.5 Step 5 Risk treatment

When Hæhre is facing risk, measures taken follow the measure hierarchy. Hæhre also states that they follow the ALARP principle when handling risks. However, when reviewing Hæhre's document, a clear definition of how Hæhre interprets what is grossly disproportionate and a description on how they implement it is missing. Hæhre only mentions this as a principle they follow, but not there is no documentation of how they are supposed to follow this principle.

However, while there is no existing documentation on how to implement the ALARP principle, The method for applying the ALARP principle is arguably through the cost-benefit assessments done in meetings and following the steps of measure hierarchy that can be described as the current process on how to implement. In section 3.6, I discussed the reliability and validity of the thesis. This is important here because there is no clear documentation. It is through my understanding and observations of documented methods that I believe the combination of cost-benefit assessment and the measure hierarchy is how Hæhre implements the ALARP principle. For example, in one meeting, decision-makers are making a decision on how to treat a risk. They come to the conclusion that it is impossible to 1.

Remove the risk and how to face it. Through discussions, they realize that it is too expensive to substitute the equipment needed. E.g., they judged the cost to be grossly disproportionate to the benefit gained from changing equipment. Therefore they follow the measure hierarchy and move down to technical measures. In the discussion here, they come to the conclusion that the cost of implementing the measure is not grossly disproportionate to the benefit and therefore decide that this is as low as reasonably practicable.

Now that it is discussed how Hæhre implements ALARP, I will move on to how they can improve on following this principle. First, it needs to be documented how Hæhre implements the principle and how the grossly disproportionate factor is applied. The literature from section 2.9.1 recommends applying a layered approach as a suitable method for implementing this principle as long as it is interpreted in a dynamic way ranging from two extreme perspectives. Hæhre's process on deciding on a measure already covers steps 1 and 2 through their meetings and qualitative cost-benefit assessment. It is recommended that they add the third step, the checklist, that covers other aspects than expected values. By implementing step 3 into their method for applying the ALARP principle, measures that they may not implement because it is not justified on expected values can be justified on other important aspects.

By creating a document that will define these features, Hæhre will improve its risk treatment methods by making it more transparent and easy to see why the decisions are being made, and the company will follow the same decision-making principle across the entire organization if there are clear guidelines on how the principle is implemented.

It is also interesting to look into the numbers from the analysis of the risk-reducing measures. The purpose of this analysis was not only just to see how many percent of the documented risk assessments had their own risk-reducing measures that were specified for their project. It was also interesting to see if there is any relation between the numbers of copied/similar risk descriptions in the management system to the description of the measure. Do a high amount of copied risk descriptions influence so that the project-specific measures are only general risk-reducing measures? Did the 85 % of non-existing project risk descriptions and copied risk descriptions influence the project-specific measures? When asking these questions, one might think that this is logical that it would. However, in reality, the majority of the documented risks have their own project-specific measure. While 33 % is still a high number of risks that do not have any specific measures related to the project, and in addition, it also may be that there is no need for any project-specific measure. It is interesting to see that the high amount of copied risk seems to have affected how Hæhre treats the risk in the project. In

total, 66% have specific measures tailored to the project. I believe this may have something to do with the meetings often referred to in the project-specific risk description, which means that during these types of meetings, they discuss the hazards in a project and how to handle them, which in return leads to a high percentage of project-specific risk measure.

6 Conclusion

The purpose of this master thesis was to figure out in what way Hæhre Entreprenør can improve its risk management practices. Three questions where to created to help answer the research question. These were: how does Hæhre manage risk, and what exactly is being done when assessing risks? And what are Hæhre's principles for managing risk? In order to answer these questions, a qualitative study was conducted that studies Hæhre's holistic risk management document. In addition, an analysis of a total of 100 risks was judged on seven different criteria, and also two separate analyses were done on risk identification and risk treatment. All this was done in order to find out if there are any challenges with the current practices and if Hæhre's risk management is in line with risk science and, most importantly, give Hæhre some points that will help improve their risk management practices. In total, 10 points have been identified where Hæhre can improve their risk management practices.

6.1 Hæhres 10 point of improvement

6.1.1 Hæhres perspective on risk

In the first part of the discussion, we discussed Hæhre's perspective on risk. According to themselves, their risk management clearly addressed uncertainties. However, when going through the data, it was discovered that uncertainties in most cases were not taken into account, and Hæhre's perspective on risk is more like the traditional consequence X probability = risk. In order to improve this, Hæhre can:

Point 1: Update their holistic risk management document with a clear definition of what risk is and how to measure risk in different situations so that there is a common understanding across the organization. The recommended definition of risk was discussed in section 5.1.

6.1.2 Issues with ISO 31000, and acknowledging uncertainties and strength of knowledge.

The second part of the discussion was about some issues that arise when basing their risk management on iso 31000. The most important takeaway was how the standard influenced Hæhre's adaptation of uncertainties. The standard expresses uncertainty through likelihood (probabilities). This also leads to Hæhre's adaptation of uncertainty being likewise, as they only used likelihood in their risk assessment as a way of expressing uncertainty. In addition, do the standard lack any explanation of key terms like uncertainty, knowledge, and

information. Resulting in Hæhre's holistic risk management document also lacking any explanation on this. This leads us to the point of improvement:

Point 2: Hæhre needs to acknowledge the strength of knowledge regarding the information the risk assessment is based on. This will lead to a more robust and reliable risk assessment that addresses uncertainties. And should also update their holistic risk management document with explanations of these key terms.

6.1.3 Enterprise risk management and task risk management

I also shortly discussed Hæhre's principle 1 for risk management and how the standard may have influenced the principle. This was only briefly mentioned because ERM is such a large field so that it would fall out of the scope of this thesis. This point is something that Hæhre should at least be aware of the relationship between ERM, TRM, and PRM.

Point 3: Implement the overruling principle of ERM so ensure that projects follow the same path as the organization.

6.1.4 Scope and purpose of the risk analysis

For the fourth point, I discussed that the goals of the risk assessment were lacking. However, adding these to each different risk assessment would just be redundant because the goal is to bring risks that cannot be eliminated or substituted down to an acceptable level. However, there is still one simple thing that could be done here:

Point 4: Adding information on what the goal for the risk assessment for the risk that must be there when performing the work into the holistic risk management document.

6.1.5 Improvements on risk identification (central risk register)

Hæhre's risk identification process is done in three different ways, specialist review, databases and tools, and brainstorming. It was quickly established from the result of the analysis that when establishing a new risk register for a project, these risks often were just copied and pasted over from the central risk register. This high number of copied risks increases the possibility of there being risks in the project that do not account for aspects that are now relevant to the risk. It was also discovered that a typical feature that often occurred was the reference to a meeting that has taken place. While I cannot conclude what has taken place in these meetings, it was discussed that it might be during these meetings that project-specific aspects of risk were discussed but not documented.

Point 5: When using the central risk register for risk identification, each project-specific risk should include its own description of the risk with descriptions of aspects relevant to the project.

6.1.6 Improvements on risk identification (identification process)

There is also no guidance on how to conduct these brainstorming identification processes mentioned in point 5. This leads us to the next point.

Point 6: Implementing a common guideline on to structure these brainstorming meetings, either by creating their own based on current practice or the one recommended in this thesis by adopting a combination of the checklist method (central risk register) to identify 80 % of the risk, and the SWIFT method to identify the last 20 % of the risk.

6.1.7 improvements on risk assessment process

The result from the different analyses showed us that Hæhre's risk assessment ability to provide an informative risk assessment varies in the degree of the details provided for the risk assessment. One reason for this may be that Hæhre lacks a description of how to conduct the risk assessment and what the risk assessment shall include, and this is again another issue that may have arisen from the poor guidance provided by the ISO 31000 standard.

Point 7: Provide a clear description of the process of a risk assessment which includes what the risk assessment should consist of so it creates a better risk picture. The description should capture and describe three main factors: cause analysis, consequence analysis, and judgments about probability and uncertainty, which captures judgments based on SoK.

6.1.8 Divide events, consequences and probabilities

It has been established that Hæhre's current method for assessing risk is based on consequence X probability. One of the problem with this is that it is currently impossible to separate unique consequences and their respective probabilities. In addition to this, there is no weight given to uncertainty and SoK.

Point 8: Hæhre should implement a new updated system with the ability to further separate the different probabilities for events and consequences that also add judgments about SoK has been recommended. See section 5.3.3 for how this would work.

6.1.9 Improvement's on the risk matrix

Hæhre's current way of evaluating risk is based on a scale from 1-25 split into green, yellow, and red categories. Then is used in a risk matrix to illustrate the results. However, there are some severe limitations to Hæhre's risk matrix. Firstly since it is based on the same criteria as the risk assessment, it fails regarding the abovementioned points. This leads us to the next point. This point builds upon point 8 because, with the current method, it automatically creates a point in the risk matrix when filling out the risk assessment.

Point 9: Like the current method automatically creates a point in the risk matrix, the new method recommended will also create three unique matrixes that clearly separate and illustrate the probability for each consequence and event, with the addition of judgment of SoK in the risk matrix.

6.1.10 Improvement's on the ALARP principle

Lastly, it was discussed how Hæhre treats the risks they are facing. Firstly unlike the risk identification process that lacks project-specific details, the risk treatment analysis showed that a high percentage of the project specific risk includes their own project specific measure. Hæhre treats their risk is by following the ALARP principle. While the lack of any documentation of how Hæhre follows this principle, it was argued that it is through a combination of cost-benefit assessments and the measure hierarchy that Hæhre implements the ALARP principle.

Point 10: Hæhre needs to document and describe how they implement the ALARP principle and how they interpret the grossly disproportionate factor. In Section 5.2.5, I've recommended a method based on the literature on how one can implement the principle

6.2 Future research

The main limitations of this masters were the inability to compare to likewise studies, making inferences, subjective judgments from someone inexperienced in the construction industry, and the inability to generalize. However, with the results from this study, in the future, it will be interesting to look more closely into more specific parts of this study and compare it to other construction companies in Norway. This may, for example, be a study that solely focuses on risk assessments in different construction companies and to what degree they create an informative risk picture. With more companies to look into, it will create a more reliable data set, and one might be able to figure out and generalize whether or not the Norwegian construction industry's risk assessment processes are good enough in terms of the

literature. Another example of future research can be where they solely focus on how the industry treats risk. With a different research design, they might be able to conclude with a stronger degree of certainty, instead of like in this thesis, where it only could be discussed and reasoned for how the risk treatment is done. It would also be interesting to see if a person with experience in the construction industry would come to the same conclusion as I did.

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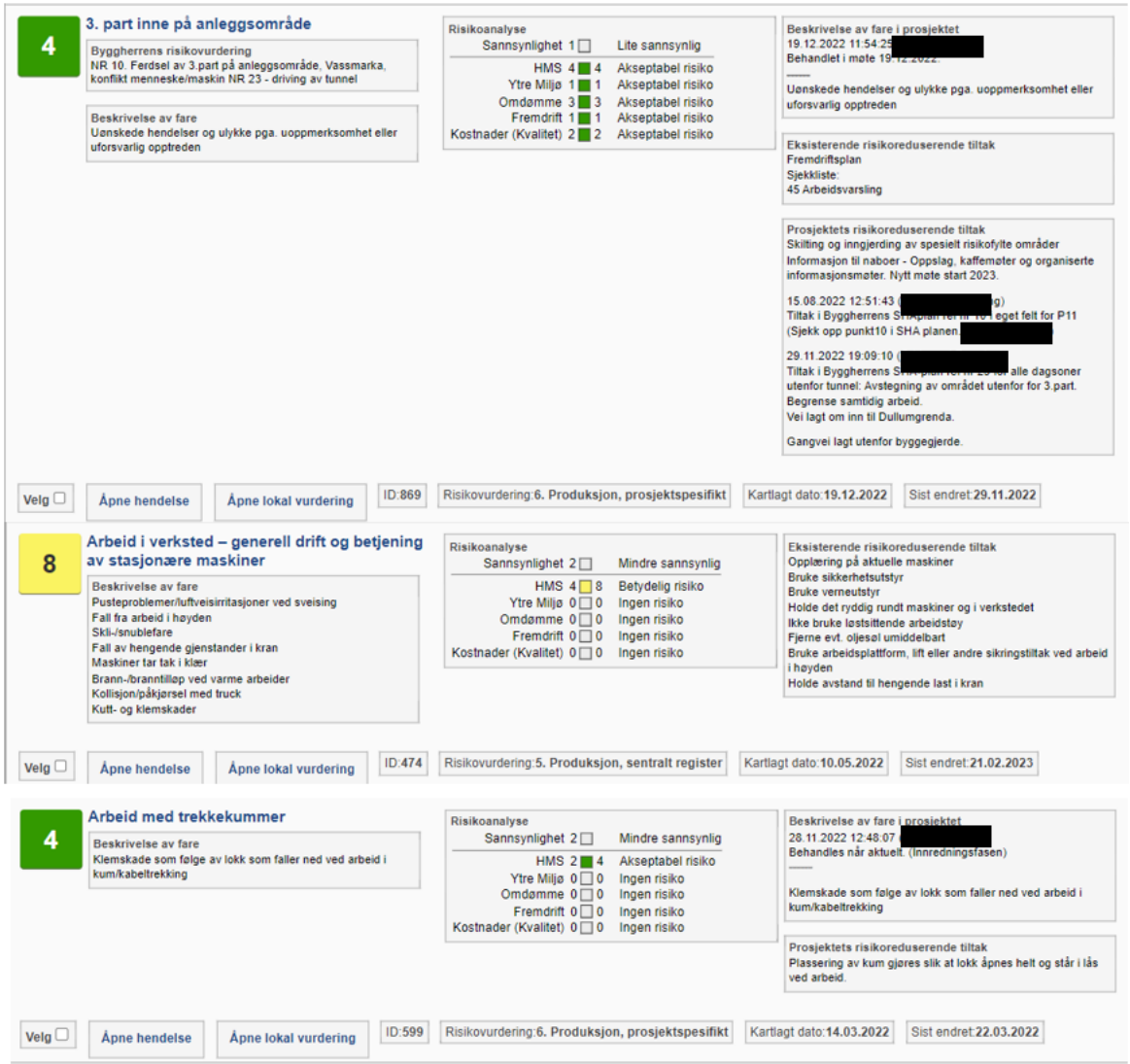
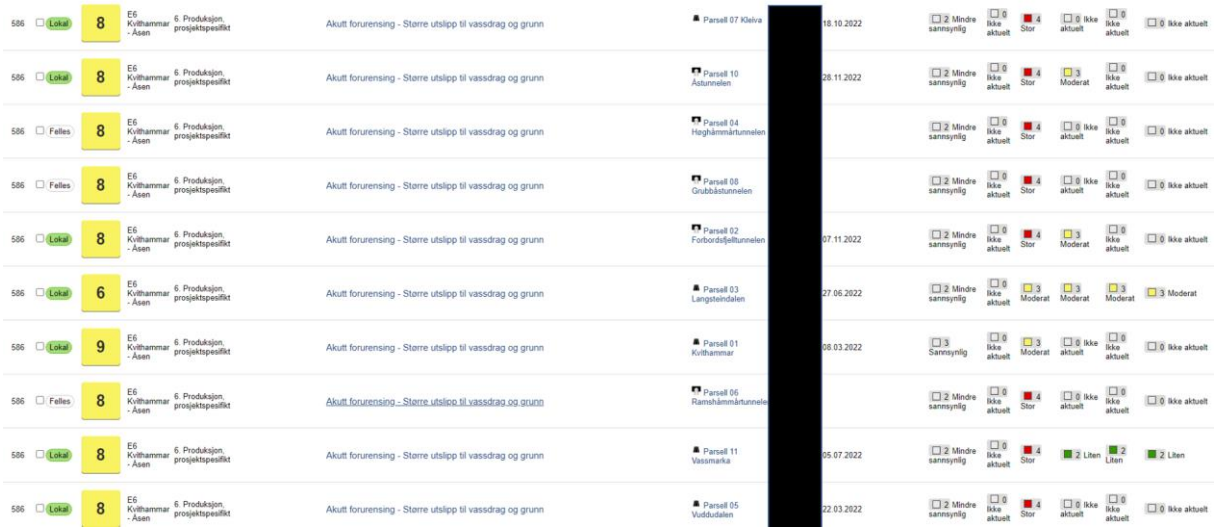
Appendix list

Appendix 1 examples of some documented risk assessments

Appendix 1.1 Detailed risk presentation



Appendix 1.2 List risk presentation



Appendix 1.2.1

Appendix 2

Eksisterende risikoreduserende tiltak

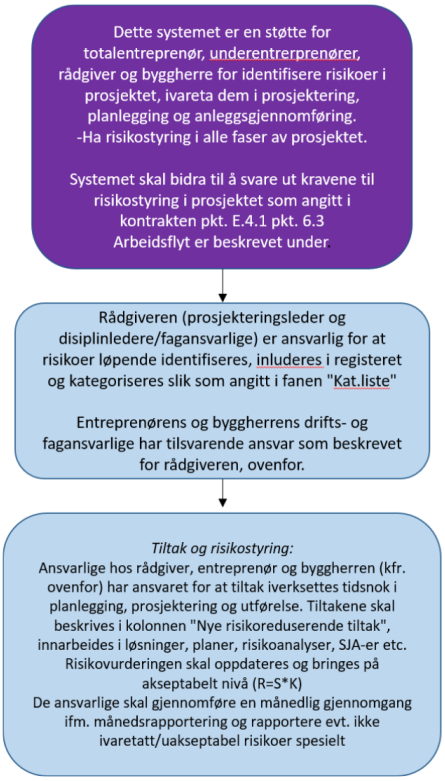
- Sentral risiko: "nr 648 Fysisk arbeidsmiljø" omtaler vibrasjoner blant flere fysiske arbeidsmiljøfaktorer, men behov for utvidet risikovurdering både på prosjekt og sentralt register.
- gjennomgang av BHT Avonovas kartleggingsrapport for Hæhre entreprenør AS, "Maskinføreres eksponering for helkroppsvibrasjon", 25. november 2022
- Deltagelse i BNLs IA-program2019-2022, med delprosjekter rettet mot vibrasjonsskader.
- Prioriterer ny maskinpark i alle prosjekter
- Har oppnådd meget godt utviklingssamarbeid, bl.a. opp mot ergonomi og vibrasjonsforbedringer, med nåværende dumperleverandør, Doosan. Tidligere ikke vært mulig med tilsvarende utviklingssamarbeid med andre leverandører.
- opplæring og ledelse for dumpersjåfører

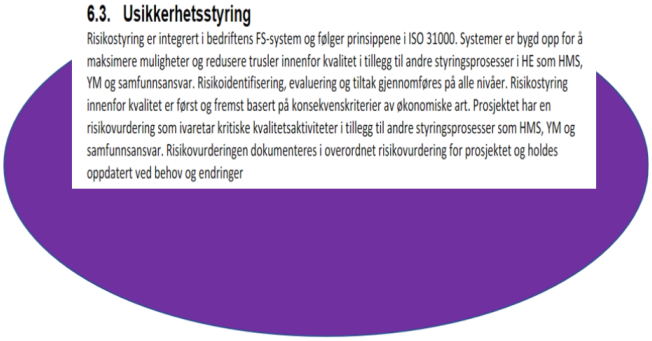
Prosjektets risikoreduserende tiltak

28.09.2022 12:30 Risikovurderingsmøte - [redacted] fagleder anleggsmaskiner [redacted] fagleder dumper; [redacted] HVO; [redacted], fagleder seriøsitet (Hæhre sentralt); [redacted]ik, dumperbas; [redacted] fagansvarlig; [redacted] - HMSK-leder (prosjekt E6 Kvithammar-Åsen) og [redacted] fra BHT Avonova. Lokalt verneombud var innkalt, men deltok ikke.

- Pilotprosjekt med Doosan for utvikling og produktforbedring, eks:
- dempere byttet ut 6 ganger siste året på bakgrunn av tilbakemeldinger fra sjåfører
- testsete montert i den ene dumperen
- elektronisk sanntids måling av dekktrykk, og utvikling av terskelnivåer for displayvarsel (i samråd med dekkleverandør).
- Gjennomføre målinger av helkroppsvibrasjoner - prioritere dumpere først, deretter bulldosere og gravemaskiner.
- Løpende vedlikehold av anleggsveier
- Opplæring og oppfølging av sjåførenes tilpasningsmuligheter i maskiner - på dumper følges dette opp av dumperbas

Appendix 3

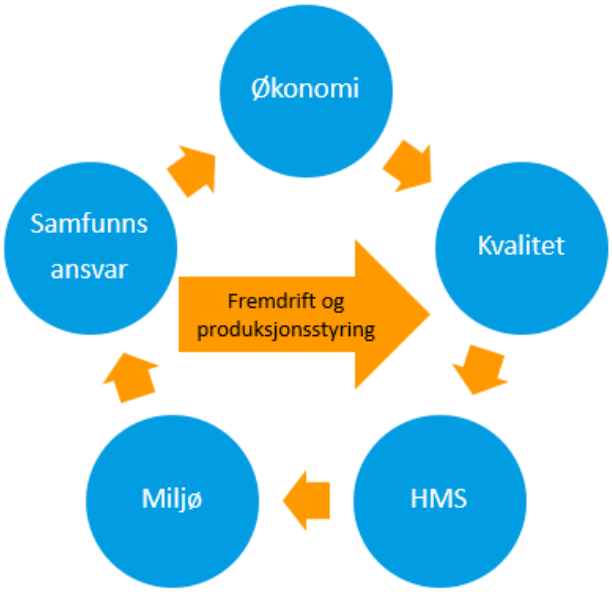

Dette systemet er en støtte for totalentreprenør, underentrerprenører, rådgiver og byggherre for identifisere risikoer i prosjektet, ivareta dem i prosjektering, planlegging og anleggsgjennomføring.
-Ha risikostyring i alle faser av prosjektet.
Systemet skal bidra til å svare ut kravene til risikostyring i prosjektet som angitt i kontrakten pkt. E.4.1 pkt. 6.3
Arbeidsflyt er beskrevet under.
Rådgiveren (prosjekteringsleder og disiplinledere/fagansvarlige) er ansvarlig for at risikoer løpende identifiseres, inluderes i registeret og kategoriseres slik som angitt i fanen "Kat.liste"
Entreprenørens og byggherrens drifts- og fagansvarlige har tilsvarende ansvar som beskrevet for rådgiveren, ovenfor.
Tiltak og risikostyring:
Ansvarlige hos rådgiver, entreprenør og byggherren (kfr. ovenfor) har ansvaret for at tiltak iverksettes tidsnok i planlegging, prosjektering og utførelse. Tiltakene skal beskrives i kolonnen "Nye risikoreduserende tiltak", innarbeides i løsninger, planer, risikoanalyser, SJA-er etc.
Risikovurderingen skal oppdateres og bringes på akseptabelt nivå (R=S*K)
De ansvarlige skal gjennomføre en månedlig gjennomgang ifm. månedsrapportering og rapportere evt. ikke ivaretatt/uakseptabel risikoer spesielt


6.3. Usikkerhetsstyring
Risikostyring er integrert i bedriftens FS-system og følger prinsippene i ISO 31000. Systemer er bygd opp for å maksimere muligheter og redusere trusler innenfor kvalitet i tillegg til andre styringsprosesser i HE som HMS, YM og samfunnsansvar. Risikoidentifisering, evaluering og tiltak gjennomføres på alle nivåer. Risikostyring innenfor kvalitet er først og fremst basert på konsekvenskriterier av økonomiske art. Prosjektet har en risikovurdering som ivaretar kritiske kvalitetsaktiviteter i tillegg til andre styringsprosesser som HMS, YM og samfunnsansvar. Risikovurderingen dokumenteres i overordnet risikovurdering for prosjektet og holdes oppdatert ved behov og endringer

Appendix 4 Hæhres holistic risk management document

Helhetlig risikostyring

En overordnet beskrivelse av risikostyring i samsvar med NS-ISO 31000:2018 for Hæhre Entreprenør AS



Hæhre Entreprenør AS overordnede rammeverk for risikostyring

1.1 Innledning

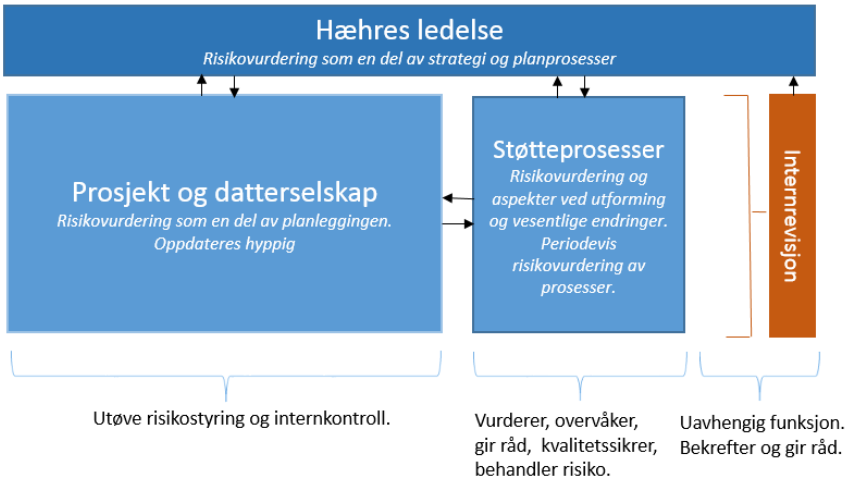
Helhetlig usikkerhetsstyring er en kjerneprosess i Hæhre Entreprenør AS (Hæhre) sitt ledelsessystem i Landax. Dette er et integrert prosessorientert ledelsessystem utformet for å gi tilstrekkelig sikkerhet for:

- Måloppnåelse innenfor HMS, kvalitet, ytre miljø, økonomi, arbeidsmiljø og samfunnsansvar.
- Ivaretakelse av kravet om målrettet og effektiv drift.
- Pålitelig ledelsessystem for rapportering og overholdelse av lover og regler.

Risikostyring er en del av kulturen i Hæhre og favner alle aktiviteter på alle nivåer i bedriften for å rettlede og kontrollere. Risikostyring i Hæhre baserer seg på prinsippene i NS-ISO 31000:2018. Dette innebærer å minimalisere uønskede hendelser og trusler, styre usikkerhet og maksimere potensielle muligheter i bedriften. Risikostyring bidrar til å sikre Hæhres måloppnåelse gjennom:

- Å identifisere, måle, overvåke og rapportere alle vesentlige risikoer bedriften er eller kan bli eksponert for.
- Å etablere hensiktsmessige risikostrategier for å styre risiko.
- Etablere beredskapsplaner for å håndtere konsekvensene av gjenværende risiko.

Målrettet, effektivt og kontinuerlig forbedringsarbeid gjennom gode prosessrutiner, kontrolltiltak og metoder gir økt verdiskapning. Hæhre følger utviklingen i samfunnet, setter rammebetingelser og har et mål om å gjøre alt arbeid riktig første gang, og gjennomføre de riktige valgene.



Illustrasjon: Organisering av risikostyring i Hæhre Entreprenør AS

Prinsipper for risikostyring

Hæhres overordnede prinsipper for risikostyring samsvarer med prinsippene i ISO 31000: Risikostyring. Risiko og muligheter tar hensyn til kontekst, interessenter og omfang av ledelsessystem for arbeidsmiljø og sikkerhet

Risikostyring i Hæhre skal tilføre bedriften verdi, herunder maksimere muligheter og redusere trusler.

Fordelene ved benyttelse av helhetlig risikostyring øker sannsynligheten for å:

- Oppnå bedriftens mål
- Ivareta interessentene
- Forbedrer tilliten fra aksjonærer
- Minimerer tap
- SMARTE KPI
- Forbedre operasjonell effektivitet i bedriften som helhet, i prosjekter og i datterselskap
- Forbedre og redusere uønskede effekter
- Oppnå kontinuerlig forbedring
- Utarbeidelse av et pålitelig grunnlag for beslutningstakere og for videre planlegging.
- Bedre Arbeidsmiljø og rammeverk
- Økt kunnskap ved erfaringsoverføring, dobbelkretslæring

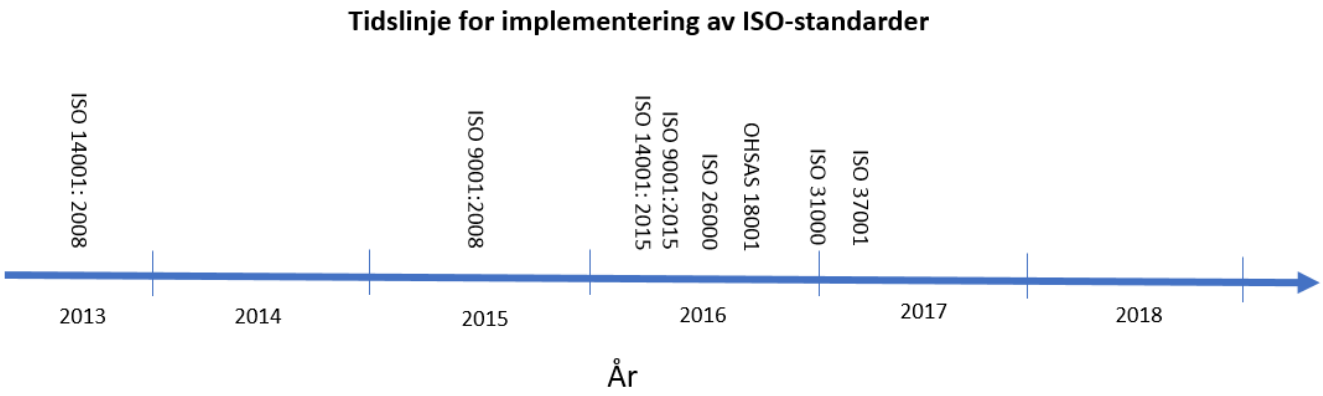
Risikostyring er en integrert del av bedriften, prosesser og i kontroller på alle nivåer i organisasjonen.

Kontinuerlig usikkerhetsidentifisering, evaluering og tiltak gjennomføres på alle nivåer og favner sosiale, økonomiske og miljømessige hensyn, i tillegg til Hæhres styringsprosesser, herunder:

- Sikkerhet, helse og arbeidsmiljø (SHA)
- Ytre Miljø (YM)
- Kvalitet (KS)
- Samfunnsansvar (CSR) inklusive Antikorrupsjon
- Økonomi, fremdrift og produksjonsstyring

Risikovurderinger og usikkerhetsstyring gjennomføres innenfor standarder som Hæhre baserer seg på eller er sertifisert innenfor. En oversikt over internasjonale standarder i forhold til økonomiske, miljømessige og sosiale hensyn er gitt i illustrasjonen under.

Illustrasjon: Posisjon av internasjonale standarder i forhold til økonomiske, miljømessige og sosiale hensyn.
** Hæhre er sertifisert innenfor denne standarden.*
Referanse: «Posisjon av internasjonale standarder» fra QuEST Forum Academy Webinar, www.questforum.org.



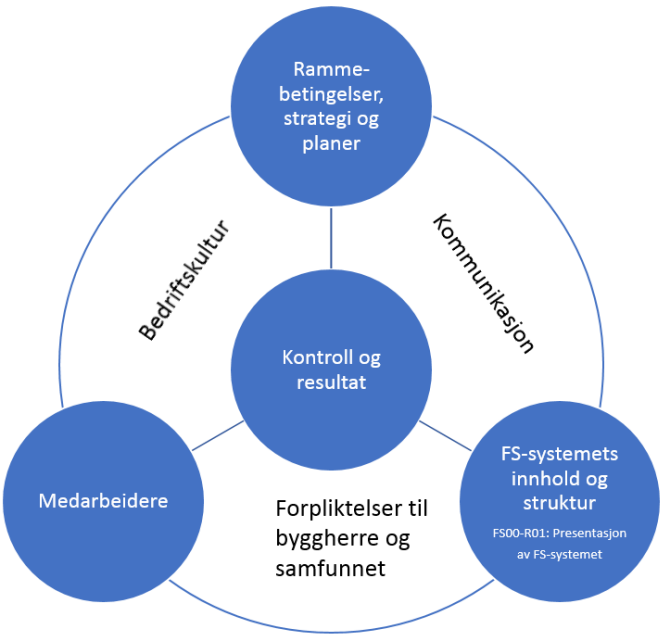
Illustrasjon: Tidslinje for implementering av ISO-standarder

2) **Risikostyring er en del av det å ta beslutninger.** Alle ledere som tar en beslutning, er eksponert for risiko. God risikostyring får ledere til å ta bedre beslutninger og dermed minimerer usikkerhet og trusler og optimaliserer mulighetene.
3) **Risikostyring adresserer klart og tydelig usikkerhet**. Ved å følge kjerneprosessen for risikostyring, dvs. identifisere, analysere og evaluere farer og ulykkessituasjoner, er eieren av risikoen bedre i stand til å implementere kontroller og håndteringer for å redusere sannsynligheten og/eller konsekvensen av usikkerhet. Dette er med på å etablere en robust organisasjon.

4) **Risikostyring er systematisk, strukturert, aktuell og tidsriktig**. Risikostyring er en planlagt og kontrollert prosess for å sikre effektivitet. Risikostyring iht. ISO 31000 fremmer et strukturert og systematisk rammeverk for å oppnå konsistente og pålitelige resultater. I Hæhre foreligger det en metodikk for å gjennomføre og dokumentere risikostyring og internkontroll på en enhetlig måte i hele organisasjonen, og risikovurderinger dokumenteres. Vesentlige retningslinjer, rutiner og kontrolltiltak foreligger skriftlig.

5) **Risikostyring er skreddersydd.** Det innebærer at risikostyringen til enhver tid er tilpasset Hæhre som bedrift. Risikostyring er med på å vurdere Hæhres interessenter, kontekst og risikoprofil. Risikovurderingsprosessen er en integrert del av Hæhres ledelsessystem, og er tilpasset arten, omfanget og kompleksiteten i arbeidsprosessene.

6) **Risikostyring tar hensyn til menneskelige og kulturelle faktorer.** Hæhres rammeverk for risikostyring tar hensyn til kulturelle elementer, internt og eksternt hos interessenter og risikoeiere. Organisering i avdelinger og arbeidsinnholdet til den enkelte i bedriften er klart definert, og det fremgår av instrukser hvem som har ansvar for styring, måling og kontroll av risiko. Bedriftens samlede resultat er en funksjon av elementene vist i figuren nedenfor, som kobler de menneskelige og kulturelle faktorene mot ledelsessystemet.

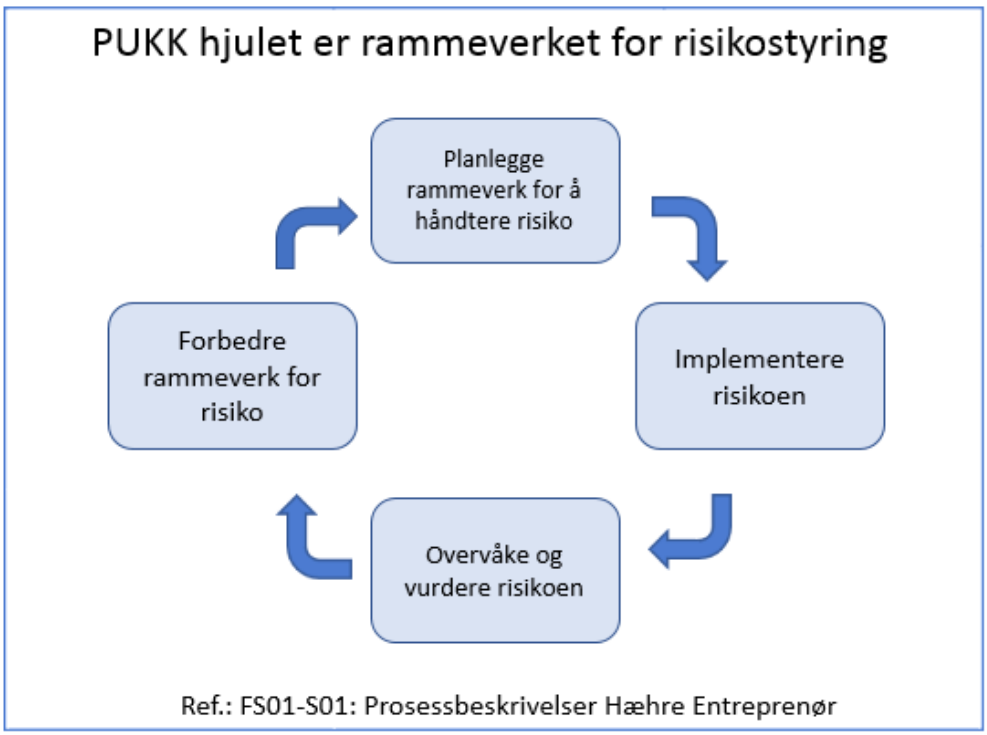


Illustrasjon: Bedriftens samlede resultat og ytelse som funksjon av ulike faktorer

7) **Risikostyring i Hæhre er transparent og inkluderende.** Dette innebærer at risikoprosessen og rammeverket er innlysende, lett å se, forstå og gjenkjenne, og virker inkluderende. Interne og eksterne interessenter har stor innvirkning på bedriften. Hæhre inkluderer interessentene og beslutningstakere i risikostyringsprosessen og de involveres i etablering og oppdatering av kontekst og risikokriterier.

8) **Risikostyring er dynamisk, gjentagende og responsiv.** Hæhre reagerer på interne og eksterne endringer, dvs. rammeverk og prosesser for risikostyring reflekterer endringer i forretningsstrategi, ledelsesplaner, økonomiske disposisjoner og organisatoriske strukturer.

9) **Risikoledelse muliggjør kontinuerlig forbedring og videreutvikling av bedriften.** Dette innebærer at risikostyringen er dynamisk og gjentagende og at rammeverk og prosess for risikostyring kontinuerlig forbedres for å bygge motstandsdyktighet og maksimere mulighetene for bedriften.

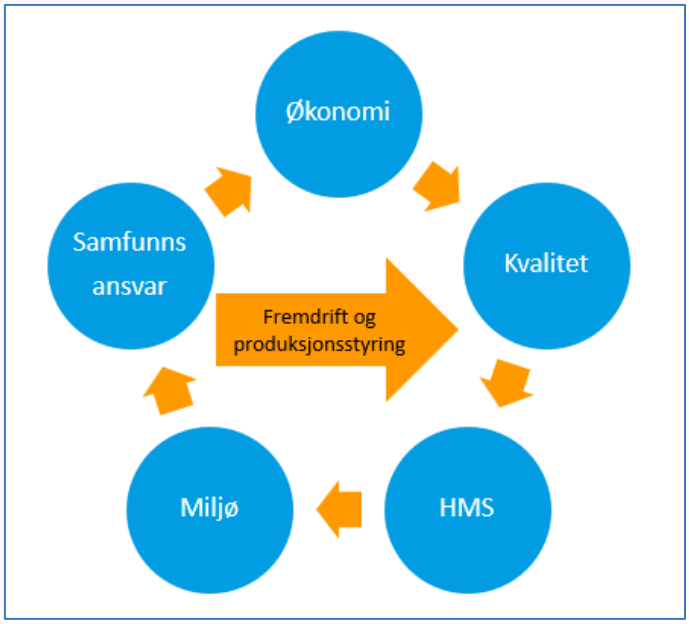


Illustrasjon: Kontinuerlig forbedring av rammeverk og prosess for risikostyring. PUKK-hjulet tilpasset risikostyring.

Prosess for risikostyring

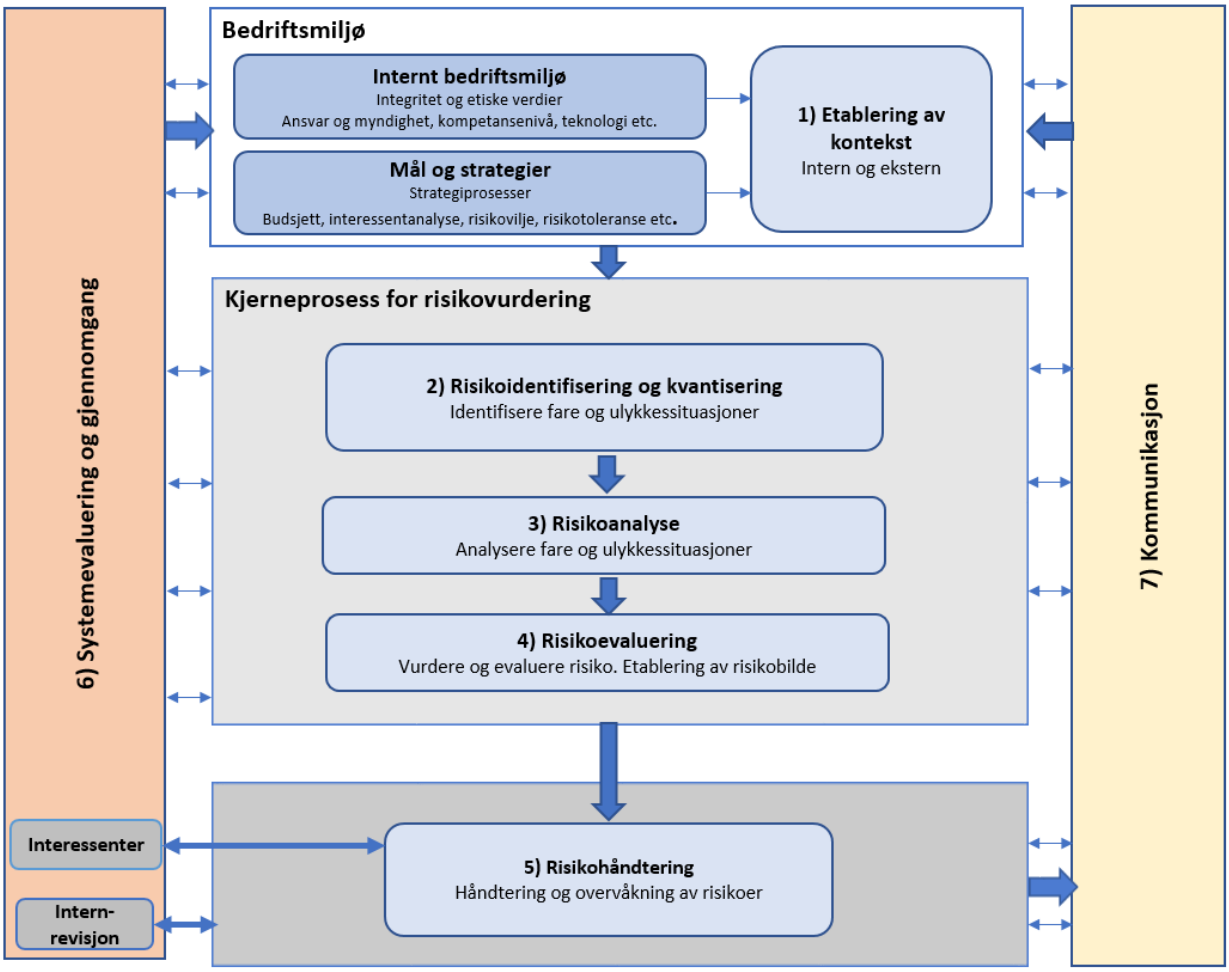
Risikostyringsprosessen i Hæhre er inndelt i syv steg. Prosesskart og detaljerte beskrivelser innenfor hvert steg er beskrevet i dette kapittelet. I Hæhre gjennomføres risikostyring på strategisk, taktisk og operasjonelt nivå:

- Strategisk risikostyring gjennomføres på ledelsesnivå og er relatert til visjoner, overordnede mål, posisjon og marked m.m. Strategisk risikostyring viser bedriftens vilje til å gjennomføre risikofylte aktiviteter, vurdere overordnede muligheter og trusler.
- Taktisk risikostyring innebærer at Hæhre har effektive risikoreduserende teknikker og kontrollmekanismer over risiko i alle Hæhres styringsprosesser som økonomi, samfunnsansvar, kvalitet, miljø og HMS i tillegg til fremdrift og produksjon.



Illustrasjon: Styringsprosessene i Hæhre Entreprenør AS

- Operasjonell risikostyring gjennomføres i prosjektet. Dette innebærer den praktiske og dokumenterte risikohåndteringen og oppfølgingen iht. strategisk og taktisk risikostyring.



Illustrasjon: Prosesskart for risikostyring i Hæhre Entreprenør AS

Steg 1 - Etablering av kontekst

Hæhres kontekst er bedriftens rammebetingelser og føringer, både interne og eksterne, som er av betydning for den videre risikostyringsprosessen. Konteksten godkjennes av ledelsen og styret, og revideres ved behov og endringer i forutsetninger internt og eksternt. Konteksten samsvarer med blant annet:

- Hæhres visjoner og mål
- Bedriftsinterne miljøfaktorer, herunder;
    - Hæhres Forretningsetiske prinsipper
    - Bedriftens uskrevne regler og bedriftskultur
- Ansvar og organisering
- Kompetansenivå,
- Bedriftens teknologiske løsninger

Hæhres kontekst er analysert i en SWOT-analyse. Analysen gir et overordnet bilde av bedriftens muligheter, trusler, styrker og svakheter i forhold til interne og eksterne interessenter, og er til hjelp og bidrag for å gjøre bedriftens svakheter om til styrker, og trusler om til muligheter.

Interne og eksterne interessenter er analysert med hensyn på innflytelse og interesse for bedriften og prosjekter i dok.: Interessentanalyse og kommunikasjonsplan. Som følge av analysen legges det opp til en kommunikasjonsplan som gjenspeiles i Hæhres kommunikasjonsplattform, dok.: Kommunikasjonsplattform.

Taktisk og operasjonell risikostyring samsvarer med Hæhres kontekst på strategisk nivå.

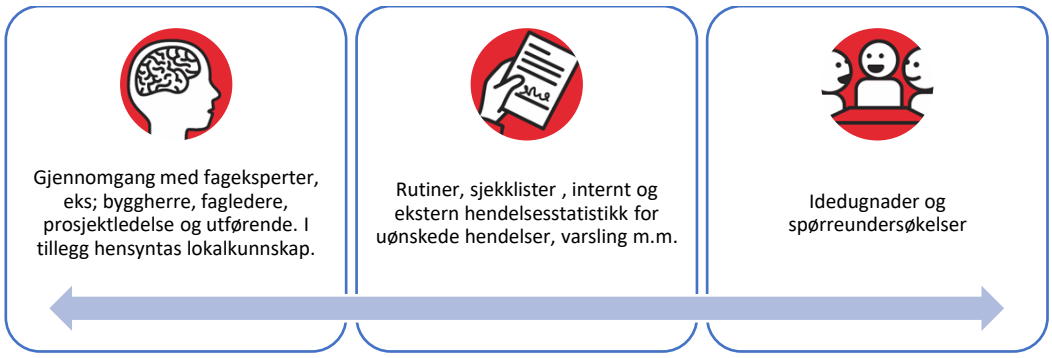
Steg 2 - Risikoidentifisering og kvantisering

Risikoindentifisering og kvantisering legger grunnlaget for videre risikovurdering og handler om å identifisere og kartlegge ulike typer trusler som kan true bedriftens mål og effektivitet. Dette gjelder blant annet trusler og usikkerheter knyttet til:

- Organisasjon, ledelse og menneske
- Politikk
- Miljø
- Arbeidsmiljø
- Operasjonelt
- Teknisk
- Strategisk og kommersielt
- Økonomi
- Juridisk

Identifisering er en del av strategisk risikostyring som gjennomføres på overordnet nivå og tilpasses for hvert prosjekt og datterselskap. Kartlagte risikoer med tilhørende beskrivelse av uønskede forhold dokumenteres i ulike verktøy for risikovurderinger i Landax, ref. Vedlegg A: Utvalg av verktøy for risiko og usikkerhet i ledelsessystemet med tilhørende risikoteknikker.

Metode for identifisering gjennomføres ved hjelp av ulike aktiviteter. Valg av metoder avhenger av om identifiseringen er overordnet eller prosjektspesifikk.



Oppsummert baserer identifisering av risiko seg på:

- Rapportering av uønskede hendelser i bedriften, oppfølging og evaluering av trender fra månedsrapporter, dok.: Avvik og korrigerende tiltak.
- Rutiner og sjekklister i Landax.
- Byggherrens risiko i byggherrens SHA-plan
- Andre interne og eksterne erfaringer og forbedringspotensialer som samles inn via
    - Gjennomgang med fageksperter, dok.: Møtestruktur prosesskart.
    - Idedugnader og spørreundersøkelser
    - Prosjektmøter
    - Revisjonsgjennomganger
    - Innhenting av lokalkunnskap

Steg 3 - Risikoanalyse

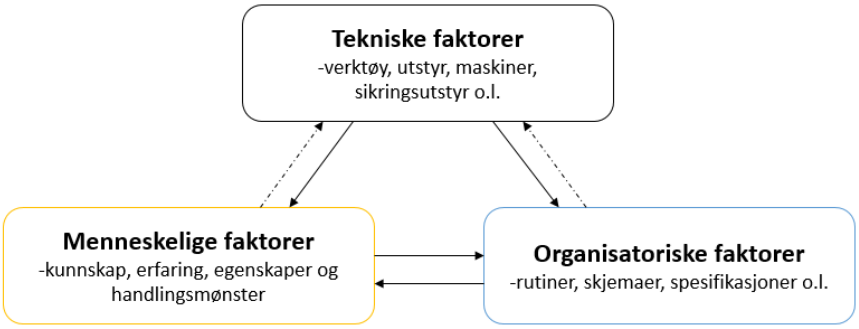
Risikoanalyse baserer seg på dagens situasjon og effektivitet i bedriften, datterselskap eller på prosjektnivå. I analyseprosessen utvikles det en forståelse av risikoen og risikonivået for prosesser og arbeidsaktiviteter.

Risikoanalysen utføres med detaljeringsgrad avhengig av risikoen, formålet med analysen og hvilken informasjon som er tilgjengelig. På overordnet nivå analyseres muligheter og trusler løpende som en del av overordnede beslutninger og bestemmelse av risikonivået i bedriften.

Innenfor Hæhres ledelsessystemer, støtteprosesser og tilpassede risikovurderinger for prosjekter og datterselskap vurderes dagens risikonivå etter fastsatte kriterier for sannsynlighet og konsekvens. Kriteriene er tydelige i de ulike verktøyene hvor risikoen

analyseres og dokumenteres, ref. Vedlegg A: Utvalg av verktøy for risiko og usikkerhet i Landax med tilhørende risikoteknikker.

Under analysen tas det hensyn til tekniske faktorer som utstyr, maskiner, sikring o.l., menneskelige faktorer som kunnskap og erfaring, samt organisatoriske faktorer som rutiner og skjemaer. Menneskelige og organisatoriske faktorer kan ikke ivareta en barriere alene og kombineres alltid med minst en av de to andre som vist i figuren under.



Illustrasjon: Menneskelige, tekniske og organisatoriske faktorer

Steg 4 – Risikoevaluering

Risikoevalueringens formål er å sammenligne risikonivået som avdekkes i risikoanalysen med fastsatte kriterier bestemt ved etablering og vurdering av bedriftens kontekst.

Risikoevalueringen kan medføre en beslutning om å gjennomføre ytterligere analyse eller håndtere risikoen ved å opprettholde fastsatte kontrolltiltak. Ved beslutning om å gjennomføre videre analyse er hensikten å vurdere ytterligere tiltak.

Steg 5 - Risikohåndtering

Risikohåndtering gjennomføres på overordnet nivå, i prosjekter og i datterselskaper. Risiko-håndtering innebærer å:

- Balansere kostnader og arbeidet forbundet med iverksettingen av tiltakene opp mot effekten av tiltaket.
- Prioritere tiltak. Det etterstrebes til enhver tid å planlegge seg vekk fra risikoen. På Hæhres prosjekter og datterselskap gjelder følgende tiltakshierarki:
    1. Fjerne risikoen
    2. Substituere/byttet ut farlige materialer, prosesser, operasjoner eller utstyr

3. Tekniske kontroller og eller reorganisering av arbeidet
4. Organisatoriske/operasjonelle tiltak. Skilting - varslingskontroller og/eller administrative kontroller/Administrative kontroller inkludert opplæring
5. Personlig verneutstyr

- Definere tiltaksplaner:
    - Implementere tiltak i rutiner og skjemaer, HMS-, KS- og YM-planer
    - Tiltaksplaner i møtereferat

- Overvåke tiltakene. Dokumenterte risikovurderinger og usikkerhetsanalyser oppdateres løpende ved behov og minst en gang i året. Nedenfor er et utdrag fra standardisert oppfølging for prosjekter og datterselskap:
    - HMS-, KS- og YM-planer med tilhørende dokument- og skjemaliste inneholder tiltak, og følges opp og oppdateres på prosjekter og i datterselskap. Krav i planverket distribueres og informeres om til underentreprenører og innleide.
    - Prosjektene har operativt ansvar for å overvåke og følge opp tiltak. Statusrapporter innenfor HMS, KS, YM og økonomi leveres månedlig til sentral ledelse som følger opp og evaluerer trender, dok.: Avvik og korrigerende tiltak
    - Gjennomgang av uønskede hendelser knyttet til HMS og YM på internmøter og møter med byggherren.
    - Internrevisjon, dok.: Revisjonsprosessen

Steg 6 - Overvåkning og gjennomgåelse

Overvåkning og gjennomgåelse av tiltak sikrer at systemer og prosesser fungerer etter beste hensikt, og at Hæhre samsvarer med eksterne og interne krav. Ledelsessystemet i Landax inneholder rutiner, prosedyrer og skjemaer som er bygd opp for å sikre kontroll og overvåkning i alle ledd. Sentrale forhold som sikrer god overvåkning og gjennomgåelse er oppsummert i figuren nedenfor. Den som er ansvarlig for tiltaket identifiserer de elementene som er nødvendig for å overvåke og følge opp tiltakets funksjon.

Illustrasjon: Sentrale forhold for gjennomgang og overvåkning av tiltak

Steg 7 - Kommunikasjon

Kommunikasjon er en del av risikostyringsprosessen og danner grunnlaget for god risikostyring. Hæhre bygger på «Føre var» prinsippet og hensikten med

kommunikasjonen i Hæhre er nærmere beskrevet i:

- Kommunikasjonsprosesser i Hæhre
- Kommunikasjonsplattform
- Interessentanalyse og kommunikasjonsplan

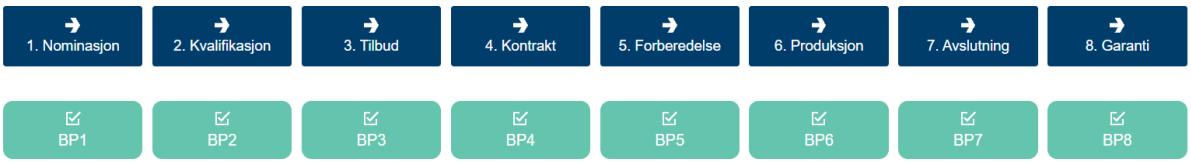
Faste møter gjennomføres på alle nivåer i organisasjonen og er beskrevet i Møtestruktur prosesskart.

Risikostyring på ulike nivåer

Risikostyring i prosjektstyringsmodellen

Hæhre har tatt i bruk Prosjektstyringsmodellen for styring av prosjektgjennomføringsprosessen. Prosjektstyringsmodellen er delt inn i 8 delprosesser:

1. Nominasjon
2. Kvalifikasjon
3. Tilbud
4. Kontrakt
5. Forberedelse
6. Produksjon
7. Avslutning
8. Garanti



Illustrasjon: Prosjektstyringsmodellen i Landax

For hver delprosess går man gjennom beslutningsporter, BP1 – BP8:

- **BP1 Nominasjon** skal sikre at virksomhetens utvalgte prosjekter tilfredsstiller overordnede strategi og interne krav, samt er i tråd med avdelingers forretningsplaner og er tilpasset avdelingens organisasjon.
- **BP2 Kvalifikasjon** skal sikre at kvalifikasjon til prosjekter tilfredsstiller virksomhetens overordnede strategi og interne krav, samt er i tråd med virksomhetens forretningsplaner og er tilpasset dens organisasjon.
- **BP3 Tilbud** skal sikre at innleverte tilbud tilfredsstiller virksomhetens overordnede strategi og interne krav, samt er i tråd med virksomhetens forretningsplaner og er tilpasset dens organisasjon
- **BP4 Forhandling** skal sikre at kontraktsforhandlingene med byggherren ivaretar forutsetningene for tilbudet, og sikrer Hæhres interesser, samt at kontrakten signeres
- **BP5 Forberedelse** skal sikre at det gjennomføres gode forberedelser med ressursplanlegging, fremdrift og nødvendige tillatelser og starte innkjøpsprosessen før fysisk oppstart av prosjektet.
- **BP6 Produksjon** skal gjennomføres etter et fastsatt intervall gjennom hele prosjektperioden.
- **BP7 Avslutning** skal sikre at prosjektet er klart for å levere til kunde.
- **BP8 Garantiperiode** skal sikre at garantiperioden blir gjennomført uten feil og mangler og iht. kontrakt.

Risiko i beslutningsportene styres gjennom risiko- og mulighetsanalyse i hvert trinn.

Prosjektets risikovurdering, operasjonelle risikovurderinger og SJA

Det gjennomføres en overordnet risikovurdering på HMS og miljø i tilbudsfasen som bygger på byggherrens SHA og YM-plan, kontraktens krav og internt risikoregister.
Risikovurderingen viser eksisterende tiltak som er godt innarbeidet i selskapets styringssystem, i tillegg til tiltak utover krav i lov og kontrakt. Risikovurderinger legges til grunn for oppdateringer av byggherrens SHA-plan, i tillegg til prosjektets HMS planverk. Gjennom overordnet risikovurdering, operasjonelle risikovurderinger og sikker jobbanalyser identifiseres mulige uønskede hendelser slik at det kan etableres tiltak og barrierer for å fjerne risikoen helt, eller redusere den til et nivå som kan aksepteres.

I utgangspunktet vil vi som hovedprinsipp redusere risiko mest mulig gjennom risikovurdering, planlegging, valg i gjennomføring, rutiner og instrukser. I tillegg til den overordnede risikovurderingen for prosjektet blir det gjennomført løpende operasjonelle risikovurderinger. Anleggsledere og driftsledere har ansvar for å gjennomføre disse innenfor sitt tiltaksområde. HMS-leder bistår driftsledelsen i dette arbeidet.

Dersom det oppstår endringer i planer og uforutsette situasjoner skal det gjennomføres en sikker jobb analyse for å vurdere sikkerheten og iverksette tiltak. Alle som utfører arbeidsoppgaven, inklusive UE/innleide går igjennom de faremomenter som kan oppstå og finner løsninger som i størst mulig grad reduserer risikoen for skader og uønsket effekt på miljøet. Sikker jobbanalyser dokumenteres elektronisk.

Det velges tiltak som først og fremst fjerner risikoen, ALARP-prinsippet, gjennom god planlegging, og tilrettelegging som minimerer sannsynligheten for at en uønsket hendelse inntreffer. Før oppstart av driftsfasen ønsker prosjektets ledelse i samarbeid med byggherre å gjennomgå risikoregisteret for hovedprosessene i et tverrfaglig møte for å sikre et gjennomtenkt risikoregister med tiltak før oppstart. Målet er å identifisere og verifisere tiltak og analysere at tiltakene er på et akseptabelt nivå. Risikoregisteret og vurderinger vil være et levende dokument som oppdateres og holdes vedlike gjennom prosjektets levetid.

Vedlegg: Utvalg av verktøy for risiko og usikkerhet i Landax med tilhørende risikoteknikker.

Dette vedlegget viser en oversikt over utvalgte verktøy for risiko og usikkerhet med tilhørende risikoteknikker. Tabellen viser og hvor de ulike risiko og usikkerhetsvurderingene gjennomføres.

Dokument	**Risikoteknikk**	**Omfang**
Risikovurdering	Sjekkliste gjennomgang Prosedyre gjennomgang Barriere analyse	Ledelse og strateginivå, støtteprosesser og i prosjekt og datterselskap
Samsvarsvurdering av lovkrav, andre krav og ledelsessystemet	Usikkerhetsanalyse	Ledelse og strateginivå
SWOT analyse	SWOT analyse	Ledelse og strateginivå
Personlig SJA	Oppgaveanalyse Observasjon Sjekkliste gjennomgang	På prosjekt og i datterselskaper
Sikker jobbanalyse	Rutine gjennomgang Oppgaveanalyse Observasjon	På prosjekt og i datterselskaper
Registrering av hendelser (RUH)	Alvorlighet- og konsekvensanalyse	På prosjekt og i datterselskaper
Gjennomgang og analyse av uønskede hendelser	Rotårsaksanalyse Brainstorming Trendanalyse	På prosjekt og i datterselskaper
Ulykkesrapport og gjennomgang av personskader	Hendelsesgjennomgang Rotårsaksanalyse Trendanalyse Brainstorming	På prosjekt og i datterselskaper
Rapport beredskapsøvelse		På prosjekt og i datterselskaper
Risikoanalyse og registrering av UE og bemanningsforetak		På prosjekt og i datterselskaper
Interne rapporter	Trendanalyser, spørreundersøkelser Gjennomgå tidligere analyser	Ledelse og strateginivå,
Interne møter innenfor alle fagområder og støtteprosesser	Brainstorming, prosedyre gjennomgang, sjekkliste gjennomgang Trendanalyser med mer.	Ledelse og strateginivå, støtteprosesser og i prosjekt og datterselskap
Rutiner og sjekklister i Landax generelt	Sjekkliste gjennomgang Prosedyre gjennomgang	Ledelse og strateginivå, støtteprosesser og i prosjekt og datterselskap