KTH ROYAL INSTITUTE OF TECHNOLOGY

Degree Project in Technology, Work and Health

Second Cycle, 30 credits

Are legal requirements enough for preventing occupational accidents?

Analysis of the main reasons why health and safety risks are traveling through a system

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Stockholm, Sweden 2023

TRITA – TRITA-CBH-GRU-2023:177

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6/20/23

Master Thesis

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Abstract

The increasing number of occupational health and safety issues is a problem. Legislations that are anchored in European law, such as “machinery directive 2006/42/EC”, the “Use of work equipment 2009/104/EC” and the Swedish AFS 2001:1 (Systematic Work Environment Management) are defined but still lack the power to stop accidents/ incidents from happening. When risks are being made conscious they are not stopped by the legal requirements in place.

Scientific approaches such as the Swiss cheese model, safety management systems (SMS), and HTO (Human- Technology- Organization) explain how increased complexity inside a socio-technical system needs more attention. As the cases of accidents/ incidents in an occupational setting still increase a need for solving this appears, with the help of science-based tools.

In cooperation with the company AFRY, I conducted four interviews (n=4) and analyzed two ABRA (activity-based risk assessments) already conducted by the company. Using the common themes identified from the interviews to analyze the ABRA helped to identify two key problems: unclear communication and insufficient knowledge.

With that in mind, I’m advocating for an increased emphasis on risk communication and resilience engineering. With the awareness that communication must be clearer and that knowledge has to be increased, it is possible to work proactively on decreasing occupational accidents by mitigating the risks.

Keywords

Machinery directive, Systematic Work Environment Management, Swiss Cheese Model, HTO, Risk mitigating, Occupational Health and Safety

Sammanfattning

Det stigande antal av arbetsrelaterade olyckor är ett problem. Europeiskt förankrade lagar såsom “maskindirektiv 2006/42/EG”, “användning av arbetsutrustning 2009/104/EG” och den svenska AFS 2001:1 (SAM) är definierad men har inte förmågan att förhindra olyckor/ tillbud från att ske. Trots att en risk har blivit upptäckt är den inte stoppad av de lagkrav som finns på plats.

Vetenskapliga tillvägagångssätt såsom “the swiss cheese model”, safety management systems (SMS), MTO (Människa-Teknik-Organisation) förklarar hur en ökad komplexitet av ett sociotekniskt system behöver mer uppmärksamhet. Eftersom att arbetsrelaterade olyckor och tillbud fortfarande ökar, är vi i behov av en lösning med hjälp av vetenskapligt baserade verktyg.

I samarbete med företaget AFRY genomförde jag fyra intervjuer (n=4) och analyserade två ABRA (aktivitets baserade riskbedömningar) som redan hade blivit genomfört av själva företaget. Att använda de gemensamma teman som identifierats från intervjuerna för att analysera ABRA hjälpte till att identifiera två nyckelproblem: otydlig kommunikation och otillräcklig kunskap.

Med det I åtanken förespråkar jag en ökad betoning på risk kommunikation och resilience engineering. Medvetenheten att kommunikation måste blir tydligare och att kunskapen måste öka, gör det möjligt att proaktivt minska arbetsrelaterade olyckor genom att minimera riskerna.

Nyckelord

Maskindirektiv, SAM, Swiss Cheese Model, MTO, Riskreducering, Arbetsrelaterade hälsa och säkerhet

Zusammenfassung

Die steigende Anzahl von Arbeitsunfällen ist ein Problem. Europäische Gesetze wie die “Maschinenrichtlinie, 2006/42/EG”, “Benutzung von Arbeitsmitteln 2009/104/EG” und die schwedische AFS 2001:1 (Systematischer Arbeitsschutz) zur Verringerung von Unfällen am Arbeitsplatz sind bereits in Kraft. Dennoch sind sie nicht in der Lage, Unfälle vom Passieren zu verhindern. Auch wenn wir uns den Risiken bewusst sind, können sie nicht allein von Gesetzen gestoppt werden.

Wissenschaftliche Ansätze wie das Swiss Cheese Model, Sicherheits-Management-Systeme (SMS) und MTO (Mensch-Technik-Organization) erklären, dass die erhöhte Komplexität von sozial-technischen Systemen mehr Beachtung braucht. Da die Anzahl von Arbeitsunfällen weiter steigt, braucht es eine Lösung mit Hilfe von wissenschaftlich fundierten Hilfsmitteln.

In Zusammenarbeit mit dem Unternehmen AFRY habe ich vier Interviews (n=4) durchgeführt und zwei ABRA (aktivitätsbasierte Risikobewertungen) analysiert, welche bereits von der Firma durchgeführt wurden. Die in den Interviews identifizierten gemeinsamen Themen haben die Grundlage für die Analyse der ABRA dargestellt und dabei geholfen zwei Probleme hervorzuheben: unklare Kommunikation und unzureichendes Wissen.

Auf Grundlage der Ergebnisse befürworte ich den Schwerpunkt auf Risikokommunikation und Resilience Engineering zu legen. Durch das sich dessen bewusst zu sein einer klareren Kommunikation und einem erhöhten Wissen ist es möglich Arbeitsunfälle mehr proaktiv zu reduzieren durch das Verringern von Risiken.

Schlüsselwörter

Maschinenrichtlinie, Systematischer Arbeitsschutz, Swiss Cheese Model, MTO (Mensch-Technologie-Organisation), Risikominimierung, Arbeitsverwandte Gesundheit und Sicherheit

Acknowledgments

To Fredrika, Terje and Thore

First, I want to thank my wife. Without her, this thesis and studies wouldn’t have been possible at all. Always supportive and understanding when I was busy, and she had to take care of the children. Thank you for being there and being such an awesome human being! I love you!

My children, even if they don’t understand what I was doing the last month. One was beside me the entire process and let me sleep during the night and the other one was born during the writing process. You give me purpose in being the best version of myself.

Secondly my family for always believing in me and being supportive throughout the entire process.

As well I want to thank my supervisor Mats Ericson for helping me to sort my thoughts during the writing process and always giving constructive feedback.

Finally, I want to thank AFRY for allowing me to write my master’s thesis at your company.

“Like everything else, excellence is a habit.” (Ben Bergeron)

Stockholm, June 2023

Christopher Eff

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List of Acronyms and Abbreviations

2006/42/EC	Machinery directive, legal requirement from the EU
2009/104/EC	Use of work equipment, legal requirement
AFA	AFA försäkring, Swedish insurance company
AFS 2001:1	Swedish work environment provision
ABRA	Activity based Risk Assessment
BUM	Business Unit Manager
EHS	Environment Health and Safety
EU	European Union
HTO	Human- Technology- Organization
PL	Project Leader
SAM	Systematiskt Arbetsmiljöarbete (same as AFS 2001:1 Engl. Systematic Work Environment Management,
SMS	Safety Management Systems
SWEA	Swedish Work Environment Authority
UN	United nations

1. Background

Sweden has a long tradition and a strong legislation on occupational health and safety. Being able to assess the risk in time, right before accidents occur, is still one of the hardest things to get the head around and one of the most important (Rose & Mikaelsson, 2009).

To not get hurt when working should be the highest goal to achieve for the employer and the employee. Looking at the statistics of 2021 "huvudrapport statistik" by AFA försäkring, it is obvious that the number of occupational accidents increases from 2.5 to 2.6 cases per 1000 workers which is not a good sign (AFA försäkring huvudrapport statistik 2021).

As employers and employees are obliqued to follow certain directives, such as the machinery directive (2006/42/EC) or the directive use of work equipment (2009/104/EC), the question is on how effective those are used, and under which circumstances they can be applied to increase health and safety.

The provision 2001:1 (Systematic Work Environment Management, Swedish SAM) of the Swedish Work Environment Authority (SWEA) includes the prevention of ill health and accidents at the workplace and applies to all employers. Besides those in place occupational accidents are happening.

Proactively preventing risks, that can lead to undesired outcomes, is one of the biggest goals that can be reached by following the mentioned directives and SAM (Rose & Mikaelsson, 2009). Knowing the probability of those circumstances and assessing them the right way plays a key role in risk prevention across all industries and for increasing occupational health and safety.

This thesis uses scientific approaches such as the Swiss Cheese model by Reason (1990), the risk identification framework by Wardak et al. (2008) and the HTO (Human-Technology-Organization) framework by Eklund (2003) for finding the main reasons on why occupational accidents are still happening. The used scientific approaches will help to illustrate the different interrelations in between the Human, Technology, and Organization (HTO) parts of the system and identify underlying causes of occupational accidents.

Previous research on risk ownership is mainly done for investments such as the one by Ülkü et al. (2007). Another study by Card et al. (2012) touches on the importance of a root cause analysis when dealing with accidents but only inside the healthcare system. This shows that there is a need for looking closer into risk ownership from an occupational perspective.

That will help to improve occupational health and safety and at the same time save human resources for the company and thereby addressing the UN goals for sustainable development: “3- Good Health & well-being” and “8- Decent work and Economic Growth” (Rose & Mikaelsson, 2009; https://sdgs.un.org/goals).

1.1. Errors in the system

Errors occur on a regular basis. They are the result of hazards which turn into risks and lead to accidents. Even with the best possible safety management system in place, there will be holes in the different layers of the Swiss cheese model (Reason, 2000).

The following part deals with layers that stand for a safeguard against the risk. In particular, I’m going to use the Swiss cheese model by Reason (1990). This model will help to find root causes emitting from the constantly changing environment inside a system.

Defining the different safeguards is important in order to have a common sense of what one are dealing with. The safeguards used in this thesis are different directives, a provision by the Swedish work environment authority, and human behavior inside leadership.

To understand how the different safeguards work, the holes inside the layers must be understood. They either emerge out of active failures or latent conditions (Reason, 2000).

Active failures are based on cognitive preconditions inside the human brain and have a direct influence on the system where they occur (Reason, 2000). Those cognitive preconditions can be based on two different cognitive processes: bottom-up and top-down (Osvalder & Ulvengren, 2019).

Bottom-up processes are more automated and unintentional. Stimuli detected by humans are recognized without any additional information (Osvalder & Ulvengren, 2019). Those are perceived by the human senses and delivered into the brain.

Top-Down processes rely on knowledge and former experiences of the human. These can be part of desires and expectations, adding information to the perceived stimuli. This is adding up to a more conscious level that helps to consider the stimuli properly to the human needs in a proper way.

Those two processes play a key role in understanding how active failures develop and why one differentiate them into four different parts.

The first one to consider is slips. Those can be action-based or memory-based. Action-based slips are using the right plan for solving problems but execute it wrong. Memory-based slips are similar except that the order of steps leading to the solution is altered or steps are forgotten (Norman, 2013). Slips are defined by a direct and often short-term impact on the safeguards (Reason, 2000).

Another kind of active failure can be mistakes, which can be misinterpretations of already existing rules. Don Norman (2013) characterizes three types. On the one hand, one have rule-based mistakes where the situation was analyzed the right way, but an inaccurate action was used to solve the problem.

The second one is knowledge-based mistakes which lead from a lack of knowledge to a wrong interpretation of the situation. The third kind of mistake is memory lapse- while taking care of the problem one forgets which kind of solution should be the outcome.

The last active failure is violation where the consciousness of the existing rules is ignored to either save time or be faster at fulfilling the task (Clinical Leadership Solutions Ltd, 2019).

Violations are based on consciousness and thereby rely on top-down processes to analyze the stimuli (Osvalder & Ulvengren, 2019). As the person is aware of the violations that are made, they might be not aware of the systemic consequences of committing this and how this causality might end in a serious accident (Reason, 2000).

As active failure are depending mostly on the human and the interpretations of the situations by using the bottom-up and top-down processes, latent conditions are more hidden inside the design of either the work environment or the equipment used (Clinical Leadership Solutions Ltd, 2019).

The origin of latent conditions lies within the design. Design is not solely the phenotype of something- it refers also to how a system is designed to do what it is supposed to do. One reason to improve design is to get rid of as many errors as possible by communicating clearly what to do in any case of emergency or malfunction (Norman, 2013). Another would be to design the circumstances around; the latent conditions, in such a way that an attempt to be 100% safe might be reached. While design processes often take time it is important to incorporate risk management early on (Akselsson, 2019). Incorporating experts in an iterative process where participatory methods and ongoing assessment of the risk can be helpful saving costs and can increase occupational health (Kuorinka & Patry, 1995).

The design either facilitates or mitigates the risks, including the physical and social work environment. It makes it challenging to draw a line between the actual responsibility behind the risk (Leveson, 2012).

1.2. Aim

The aim of this thesis is to map the main reasons why legal requirements such as the machinery directive (2006/42/EC), the use of work equipment (2009/104/EC), and SAM (AFS 2001:1) are not sufficient in preventing health and safety risks from traveling through a system after they've been made conscious for stakeholders at the workplace.

1.3. Purpose/ Problem

The problem investigated by this thesis is to investigate which main reasons can be found that lead to an ongoing existing of risk. This will fill the purpose to increase health and safety among workers and reach the UN sustainability goals "3- Good Health & well-being" and "8- Decent work and Economic Growth".

1.4. The Company- Goals

The company where the master thesis was conducted is AFRY (https://afry.com/en). AFRY is a consultancy company with a focus on change and a more sustainable future. They provide "engineering, design, digital and advisory services to accelerate the transition towards a sustainable society" worldwide (https://afry.com/en/about-us).

After the first contact with the company, the decision was made that the theme for the thesis should be about "Risk ownership- from machinery safety to EHS." In keeping with that theme, it was important for the company to include the legal requirements of machinery directive 2006/42/EC, use of work equipment 2009/104/ EC, and Systematic Work Environment Management SAM, AFS 2001:1 to build the thesis around those.

Using those legal requirements made it possible to look from a European perspective and make it more transparent for further use.

The division, the thesis was accompanied with, works with Safety and EHS (Environment, health, and safety). Especially of interest for my part was the machinery safety in alignment with CE marking and thereby compliance.

As the theme got more concrete after researching the literature, Afry and me decided together to look closer into how a risk, which is been made conscious, still can travel throughout the process and lead to incidents/ accidents.

Being able to figure out those causes will help to make future work safer and address risks from the beginning. The monetary value of finding one or multiple solutions is hard to describe when talking about the safety of people. One possibility could be to calculate the loss when personnel get injured, the production stops, or other fatal things happen.

Goals emerging of the cooperation:

a) Define what safety is about and which role risks play
b) Identify main reasons in the use of legal requirements through processes that lead to accidents/ incidents
c) Give suggestions for solving the problem of rising occupational health and safety injuries.

1.5. Delimitations

The thesis is limited to four employees from AFRY. This can be a bias towards the company and its way of dealing with safety and risk.

Another delimitation can be the limited amount of data provided by the company is not giving the full picture and might as well compromise the generalization of the results.

As I am using personal interviews, either online or in-person answers might always be a little bit biased toward the situation where the interview is conducted in.

Another thing to mention is that the directives used are not laws, but every member state of the EU is obliqued to follow these and embed them into one’s own laws.

1.6. Legal safeguard 1: Machinery directive 2006/42/EC

The machinery directive by the European Union, as it is used today, was first adopted in 2006 (Directive 2006/42/EC). There are different goals of this directive. One is to secure the free market of machinery inside the EU. The second and third goal are both making sure that people using the machinery are staying safe and healthy and increasing the awareness of safety by design (Jespen, 2016).

Machinery in the sense of the directive 2006/42/EC includes products such as:

a) “machinery;
b) Interchangeable equipment;
c) Safety components;
d) Lifting accessories;
e) Chains, ropes, and webbing;
f) Removable mechanical transmission devices;
g) Partly completed machinery.” (Directive 2006/42/EC, p. 26)

A machine is a device using parts that are connected, whereas one at least is moveable and uses a common source of energy, which can be electricity, fossil fuels, hydraulic energy, wind or waterpower (Jespen, 2016; *Maskiner - Arbetsmiljöverket*, 2023).

When using the machinery directive to get to a root cause of a risk one want to make sure that it is used correctly.

The main goal is to define clear stimuli which add up to a perception that is independent of top-down processes (Osvalder & Ulvengren, 2019). The use of the machinery directive is defined for the safety of the worker and their surroundings. A good understanding of which active failures or latent conditions could arise from an unclear perception is important.

The design process should include a worst-case analysis of which things can go wrong (Norman, 2013). Including this can on the one hand mitigate the risk for latent conditions to take over and result in an accident or on the other hand make sure that slips won’t play a role in the safety management (Clinical Leadership Solutions Ltd, 2019). A more robust written and executed safety guard formed by the machinery directive is mitigating the rise of a risk.

There are two main risks that can be mitigated by the machinery directive. One is the correct use of the machinery as stated by the manufacturer. An iterative risk assessment *"determine[s] the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof …" (Machinery Directive 2006/42/EC, p.35).*

The other risk that can be mitigated is ill health by making sure that the design of the used machine is adequate to fulfill the *"essential health and safety requirements relating to the design and construction of machinery" stated* in the *Machinery Directive 2006/42/EC (p.35).*

Coupling the machinery directive 2006/42/EC to Reasons' Swiss cheese model shows the importance of this first safety guard as shown in figure 1.

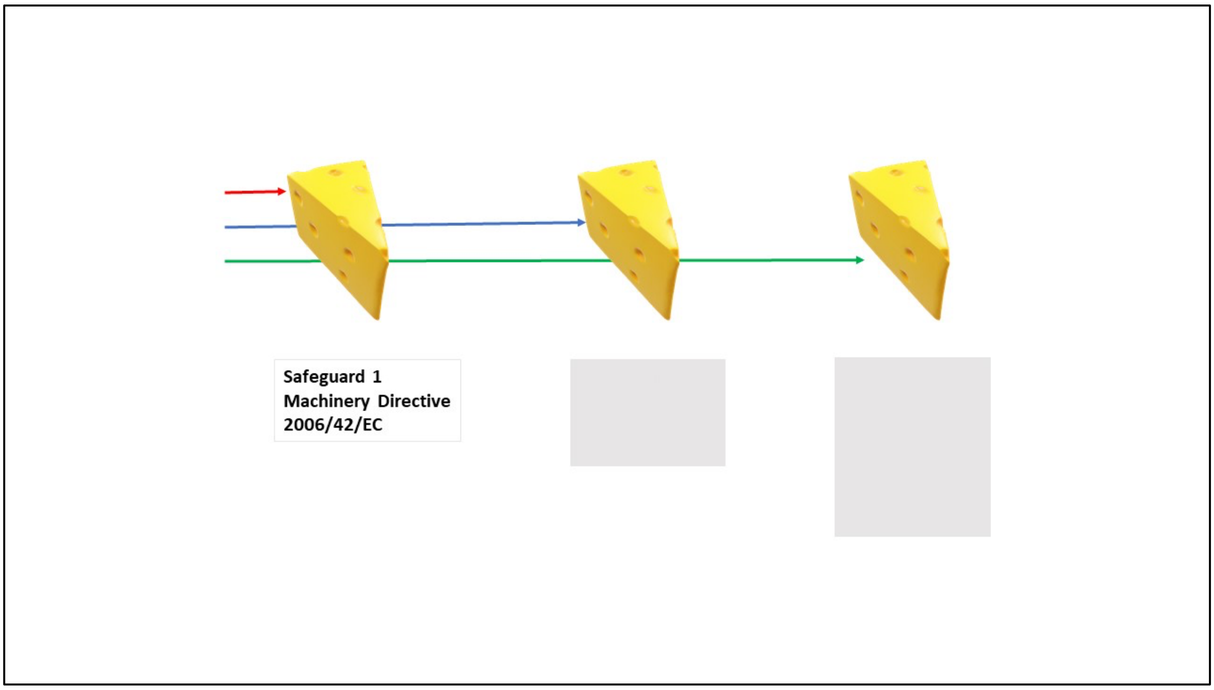

Figure 1 Safeguard 1 Machinery directive 2006/42/EC

Important to ask is how the information provided by the machinery directive document is perceived. As mentioned earlier the best way would be that everyone would perceive the same information with bottom-up processing of the stimuli provided by the document. But as this will be hard to conduct, one must put in another safeguard to make sure that the top-down processing is still leading up to a mitigated risk. This different perception of the instructions of the machinery directive can be seen as a "hole" in the Swiss cheese (Reason, 2000).

Different experiences and knowledge of the user lead to a variation of the processed stimuli and thereby perception of potential risks (Osvalder & Ulvengren, 2019).

Another safeguard, the 2009/104/EC directive “concerning the minimum safety and health requirements for the use of work equipment by workers at work” (p. 5) is used to mitigate more risks.

1.7. Legal Safeguard 2 Use of work equipment 2009/104/EC

Using the directive 2009/104/EC *"concerning the minimum safety and health requirements for the use of work equipment by workers at work" (p. 5)* requires firsthand a definition of "work equipment" and "use of work equipment".

According to the directive, the work equipment can include "any machine, apparatus, tool or installation used at work;" (2009/104/EC, p. 6). This implies that most of the work equipment used underlies the directives form the machinery safety 2006/42/EC and thereby the first safety guard mentioned earlier.

"Use of work equipment" is defined as" any activity involving work equipment such as starting or stopping the equipment, its use, transport, repair, modification, maintenance, and servicing, including, in particular, cleaning." (2009/104/EC; p.6).

The main concern of this directive is to inform the user of all necessary information needed to keep safety and health on a high level while using work equipment (Jespen, 2016).

In the sense of risk mitigation, this safety guard mostly tries to cut the active failures such as slips, lapses ,or mistakes by increasing the knowledge of the user. This top-down processing helps to merge the differences of each individual (Osvalder & Ulvengren, 2019).

Another point is that overlapping parts of both directives achieves a redundancy in having information provided by the manufacturer and at the same time point out the obligations of the user (2006/42/EC; 2009/104/EC).

This second safeguard is proactively dealing with preventing the wrong use of the equipment and gathering the correct information. Putting in another layer to protect the user from risk improves communication and awareness of the need for a risk assessment (Jespen, 2016).

According to the Swiss cheese model, this safety guard is helping to remove the misunderstood information that may have appeared out of the machinery directive or adds more reliable information for the individual using it as shown in figure 2.

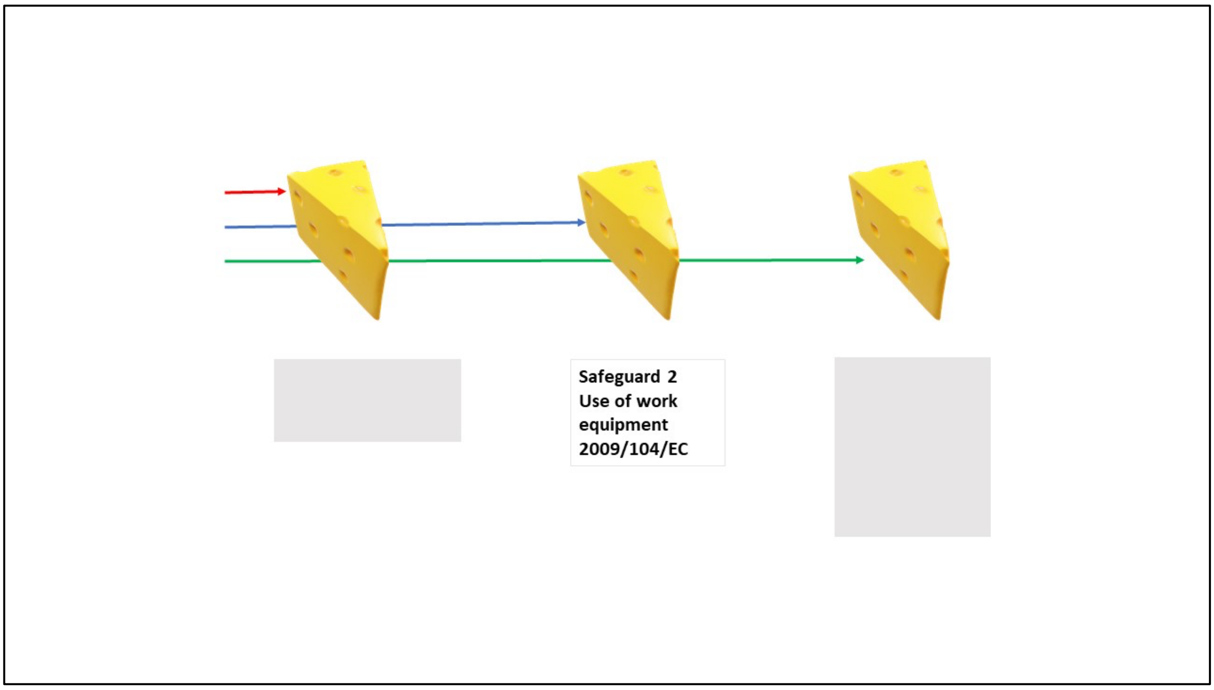

Figure 2 Safeguard 2 Use of work equipment 2009/104/EC

1.8. Legal Safeguard 3 Systematic Work Environment Management SAM, AFS 2001:1

Inside the Swedish legislation is a provision that is formulated that "ill-health and accidents at work are prevented and a satisfactory working environment achieved."(*Systematic Work Environment Management; AFS 2001*:1, p.5)

One of the premises stated in the provision is that systematic work environment management should be integrated daily inside the company.

The demand of conscious acting by everyone through collaboration is useful. In the provision different important activities are listed which the company can use for doing their systematic work environment management. Those are risk assessment, investigation, action plans, and follow-ups.

The following figure 3 shows the iterative process which can be used based on the AFS 2001:1.

Figure 3 Steps for the systematic work environment management based on AFS 2001:1

Risks that passed the first and second safeguards are tackled with a common sense of safety and safety culture by the provision. Designing the workplace in alignment with the provision is helping to mitigate any risk by reducing both active failures and latent conditions when used in a proper way.

Systematic work environment management describes a behavior for safety from different angles. A process leading up to this kind of safety culture includes steps, such as:

- Tasks
- Powers and Resources
- Knowledge
- Competence
- Allocation of tasks and responsibilities.

The commonality of those steps is human behavior and cognitive ergonomics. Cognitive ergonomics is one part of the definition of Human Factors and Ergonomics (HFE) and is defined as the following:

"Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision making, skilled performance, human-computer interaction, human reliability, work stress, and training as these may relate to human-system design.)" (IEA, 2020)

Parts of this definition can be coupled with parts of SAM and the need for design working tasks, towards a more human-centered design (Norman, 2013). Using this approach to gather knowledge by the recognition of probable risks. The perception of this risk will be highly dependent on which "tasks", "powers and resources", and "competencies" are allocated in this situation (Akselsson, 2019, AFS 2001:1). As stated earlier this kind of perception is highly dependent on both top-down and bottom-up processes inside the system of the human (Osvalder & Ulvengren, 2019).

As seen in figure 4, SAM is the third safeguard in place focusing mainly on cognitive ergonomics and the design of the workplace to mitigate the risk. Besides the cognitive part, there is as well an organizational part leading to increased responsibilities among workers. The responsibility that SAM is integrated into the everyday working processes is a question of leadership (AFS 2001:1). Forming a safety culture to reduce stress and distribute responsibilities will be part of the next chapter.

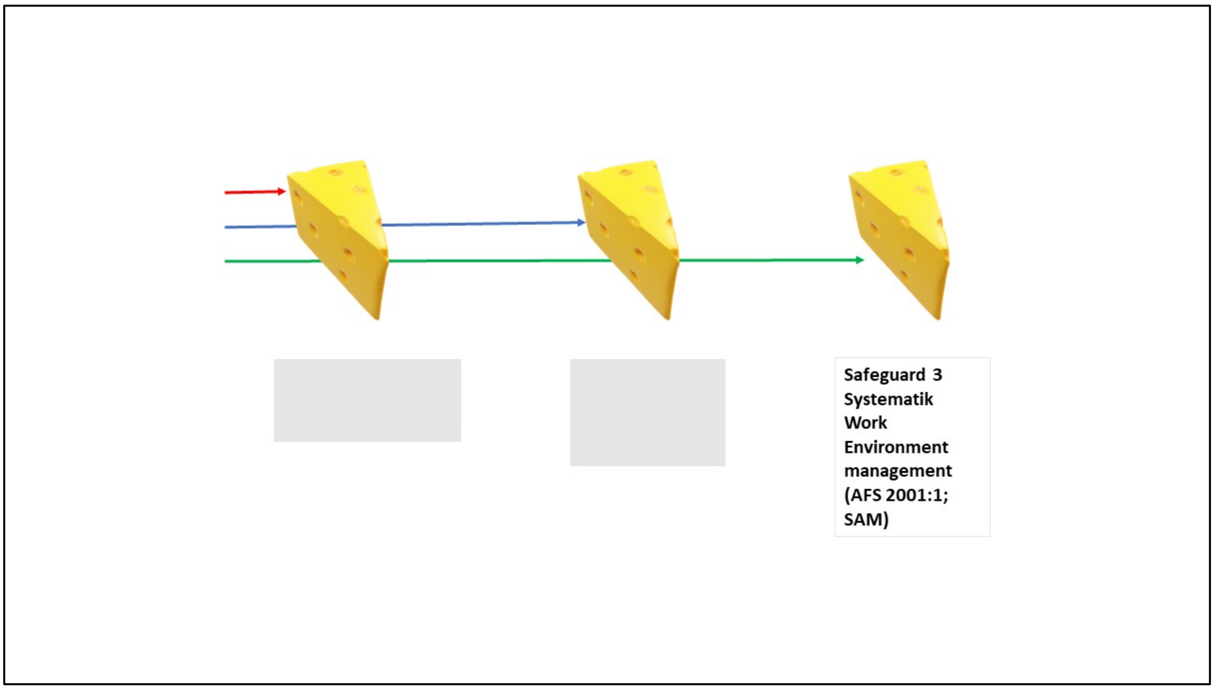

Figure 4 Safeguard 3 Systematic Work environment management (AFS 2001:1, SAM)

2. Risk in a socio-technical system

2.1. What is a risk

A risk can be understood in separate ways. On the one hand, there is the risk which can be defined with numbers. For example, AFA defines the risk of how many severe injuries per 100 workers occur (AFA försäkring, huvudrapport statistic, 2021). This can be used for the specific treatment of occupational risks, which can lead to short or long-term sick leave (Aven, 2016). Risk will always be generic to the definition it is based on. This implies that for doing an adequate risk assessment, a definition of risk must be done beforehand. As mentioned in the previous text, there are already safeguards in place that help to mitigate the potential risks. Those safeguards do not help 100% each time as the risks occurring in an occupational context often underly a higher complexity, which is not linear (Aven, 2016). Being able to assess the risk properly calls for thorough research beforehand to define the risk with the help of frameworks, different principles, and a broad view of the definition of risk in general (Aven, 2016).

In the case of this thesis, a definition of risk will be the consequences on human values in the combination of occupational safety and health (Aven, 2015). Those consequences can be perceived in separate ways. The way of risk perception involves often different cognitive aspects such as top-down and bottom-up processing while trying to administrate the level of uncertainty for each individual (Akselsson, 2019; Osvalder & Ulvengren, 2019).

Important to mention that risk perception is if the human exposure to risk is voluntary or if it is forced by bad planning/ design of the processes or insufficient knowledge of people involved in the situation (Akselsson, 2019).

In the following, I'm going to describe the complexity of the risk in a sociotechnical context and how various parts such as the human, technology, and organization can help to understand the relations between various parts of the system.

2.2. Socio-technical systems and HTO

Most of the systems in daily life are very complex (Leveson, 2012). This complexity makes it hard to understand every part separate from each other.

Dul et al. (2012) integrate the field of human factors and ergonomics (HFE) into the understanding of different systems. Thereby they name three main characteristics which HFE contributes:

1. HFE itself can be seen as a system where different parts interact with each other.
2. While looking often just at the outcome and neglecting the underlying factors, the design process is important (Nord Nilsson & Vänje, 2018).
3. The focus is on the performance of the system and the well-being of the people involved inside the system.

Understanding the complexity of the system is one part of making the system accessible for analysis (Wilson, 2014). Sociotechnical systems (STS) deal with great variance and thereby complexity. Saurin & Gonzalez (2013) describe four different components which characterize the complexity of a socio-technical system. Those four characteristics include a "Large number of dynamically interactive elements, Wide diversity of elements, Unanticipated variability and Resilience" (Saurin & Gonzalez, 2013, p.816). Using the three different subsystems suggested by Eklund (2003) with human, technology, and health it is possible to break down the complexity by analyzing the main interrelations. Another important part to see is the handling of the risk with the applied knowledge.

Being able to do that requires the division into subsystems. This enables us to sort various aspects more clearly toward the goal of mitigating the risk.

By using the suggested parts of humans, technology, and organization it is possible to break down the complexity into smaller parts. The main focus should be on understanding the processes in between the systems, rather than the systems itself (Karltun et al., 2017).

Existing boundaries in the subsystem such as "organizational boundaries, geographical boundaries, cultural boundaries, and temporal boundaries" (Carayon, 2006, p. 527) will always be there. The opportunity of implementing HTO thinking inside the sociotechnical system allows for a breakdown of the essential problems which occur in between those subsystems. Understanding the interrelations between the Human, Technology, and Organization is one of the basic concepts for this thesis. Those elements can either be analyzed vertically, functionally or by the domain (Carayon, 2006). Embedded in the purpose of the thesis it is important to see the holistic safety and how each subsystem is either beneficial or detrimental for the safety in the end.

2.3. The Risk identification framework

To understand how a risk can lead to incidents or accidents it must defined what a risk is. According to Rose & Mikaelsson (2009) "A risk is the possibility of an undesired consequence" (p. 622).

Wardak et al. (2008) suggest a framework to identify the risk. The identification process can be seen as the start of the travel of the risk after it got conscious.

Looking at the life of a risk one can determine three different stages. Those stages include the getting conscious of risk, the traveling, and the mitigation or death and are shown in figure 5.

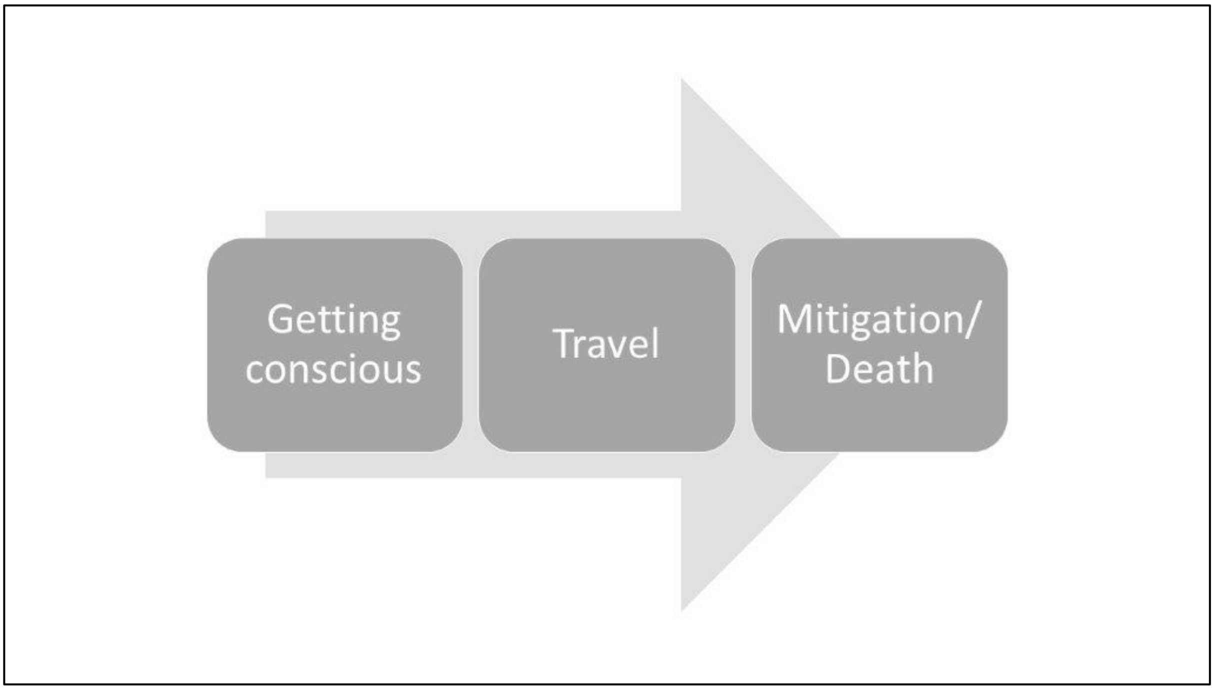

Figure 5 Travel of a risk, Eff (2023)

The following part will primarily focus on when the risk starts to be conscious and when the risk travels through the process.

In increasingly complex systems risk occurs at every time. A lack of effective communication is the starting point of many risks that might turn into incidents and later accidents (Wardak et al., 2008).

Not knowing what to do (insufficient knowledge), could as well be seen as stressor that, might add up to already existing risks (Dellve & Eriksson, 2016). While gathering information using different legislations such as the 2006/42/EC or 2009/104/EC the intention is to provide information which can be used by the employee.

As mentioned before is information not always available in the same dimension to everyone due to different top-down processes and thereby a different perception (Osvalder & Ulvengren, 2019).

The framework is divided into five distinct parts which try to solve the heritage of the risk already in the beginning.

Risk triggers can be aligned with either active failures or latent conditions as they are the basis for human error or the behind human error approach (Woods et al., 2010). Those triggers might be part either of the understanding of the legislation or the use of it in the design process.

While the design is mostly dealing with the latent conditions a concise understanding must be in place. Using systemic factors for the risk identification as a whole widens the scope of finding the most probable risk (Leveson, 2012)

Using different accident models on how risks develop throughout time helps to get a good scope of what to include in the risk identification model (Lundberg et al., 2009).

Simple linear models which show the cause and effect are easy to understand but just show one part of reality (Lundberg et al., 2009). As shown by the Swiss cheese model is linearity helpful to show how things are connected in a linear way but ignores the complexity within everything.

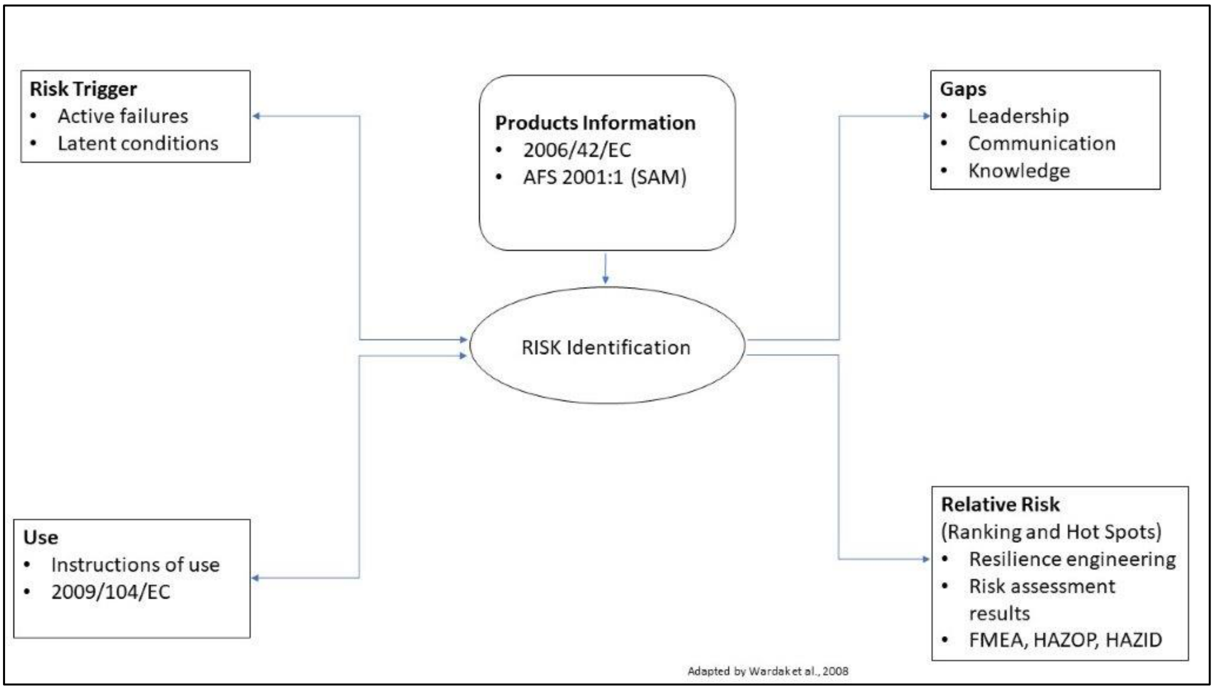

Figure 6 Risk identification model adapted by Wardak et al., 2008

The linearity inside this model is built around the creation of risk. At every time different aspects have to be taken into consideration such as risk triggers, product information, gaps, relative risk, and use as seen in figure 6 (Wardak et al., 2008).

Risk triggers can be described by the active failures and latent conditions mentioned by Reason (1990). As he mentions those aspects in the sense of “behind human error”, a higher complexity starts to appear out of this linear system.

The product information can be seen as equal to the 2006/42/EC when using a machine or the AFS 2001:1. Both provision deal with a big amount of information that has to be distributed and understood by the users (Borchard et al., 2012; Osvalder & Ulvengren, 2019).

Gaps can be seen as the “holes” in the Swiss cheese which allow risk to travel further along. The earlier mentioned safety guard leadership can be seen as well as a facilitator for the ongoing risk travel.

3. Safety Engineering

Safety is an important part of reaching health and well-being at work. In all different areas, safety needs to be achieved.

In science, one try to define subjects, such as safety, that it is valid and reliable to use. In this case, safety is knowledge, and together with engineering, createing knowledge (Hollnagel, 2014). In this thesis knowledge about legal directives from the European Union, Swedish Work environment authority regulations, and how different systems interact with each other one have to consider that there is no guarantee that “total safety” can be achieved. The thrive to mitigate the risk is always a priority. It is important to make sure that everything inside our control is used for getting closer to a safer system.

The more complex a system gets, the higher the need for reducing this complexity by looking at the root causes. Fast changes in technology, less experienced people one can learn from, and a hard time differentiating between what is important and what is not show just one part of the rising complexity (Leveson, 2012). Risks are changing all the time and call for a need for a flexible evaluation and assessment to cope with them. Cook & Rasmussen (2005) describe in their “Going solid model” that there more complex a system, the bigger the chance, that even the smallest risk leading to a mistake on one side is enough to paralyze every reaction in the future.

This “solid” status of a system can be avoided through proactive consideration of how root causes might arise and could lead up to risks, which in their turn give the basis for un-safety (Rasmussen & Svedung, 2000). A proactive approach tries to eliminate the risks by identifying, observing, assessing, and in the end mitigating without letting accidents happen.

Not only is it important to name and assess the risks. Identifying how to avoid those can contribute towards overall safety.

Making sure that everyone involved in the process understands safety and what it implies is important. Differentiating between the reliability of the system and the system’s safety. Different components are manufactured at a certain standard or directive (e.g., 2006/42/EC) to make you feel that they are reliable. Safety on the other hand implies that reliable products are risk assessed in their specific use (e.g., 2009/104/EC) before they can be considered safe (Leveson, 2012). Reliable products can be safe or unsafe, while a safe system just uses reliable products.

Numerous scientists such as Hollnagel and Levesson in “Resilience Engineering: Concepts and Precepts” try to give definitions on systems safety through the term of resilience engineering (Woods, 2006). They define resilience as the robustness of a system towards external circumstances. When using the example of Cook & Rasmussen (2005) with going solid one can see that tight boundaries do not allow much to happen that is outside of our control.

In the following I will describe the differences in how safety can be adressed. Hollnagel et al. (2015) describe two different approaches: Safety I and Safety II.

3.1. Safety I

As described earlier is safety a result of various parts. Those parts can be different directives or laws, the human operator, technological parts involved in processes, or other things such as for example natural catastrophizes.

In safety I one assume that all those different parts either work or not and as a result contribute to safety (Hollnagel et al., 2015). As a result, the interrelations of the involved parts might be overlooked. The why behind actions and results is often neglected.

When safety is defined by the absence of accidents or failures, it is often assumed that everything is good (Hollnagel et al., 2015).

Looking closer at the Human as a system it always starts with that something went wrong. Human error is quite common and often seen as the main cause of accidents (Reason, 1990). Those causes can include either slips or mistakes (Norman, 2013).

Errors induced by slips include things that were not intended to happen, such as using the correct protocol just for the wrong device because of inattention (action-based) or simply forgetting what the correct order was (memory lapse). Those unintentional slips can lead up to severe incidents.

Mistakes on the other hand can be induced by not knowing what to do in certain situations. Either by making the wrong decision (rule-based), using the wrong action for solving the right problem (knowledge-based), or getting distracted when conducting an action.

Keeping that in mind, human errors challenge the safety of the system as the part that "could do wrong"

Understanding that for safety I all subsystems involved can be analyzed separately and that there are always just two modes of choice. Either it is functioning correctly or incorrectly (Hollnagel et al., 2015).

When talking about functioning in those terms one must address the technical circumstances as well. It is harder to understand a malfunction when you are not familiar with the technology used. Information overflow and not knowing what to do can be a problem.

To keep up with the constant increasing complexity of systems and those things are not as linear as assumed a new way of thinking must be set up: Safety II.

3.2. Safety II

The significant difference between safety I and safety II is that everything inside the system must be considered when estimating risk and thereby safety. Nothing can be seen as just standing alone part- everything has to be seen as a part of the whole regarding the shift in demands thinking about errors (Hollnagel et al., 2015).

Safety II is questioning what lead up to the error in the first place. Bigger systems are dynamic and need flexibility. Every part can influence the other and vice versa. The priority lies in emphasizing things that went right and by that shifting the focus to more proactivity (Hollnagel, 2012).

As earlier mentioned, the subsystem of humans is important. With the safety II approach, it is possible to broaden our thinking and look behind human error. This means that finding the root cause by analyzing what lead to the error becomes the priority. Woods et al. (2010) emphasize that there is more trouble in the background leading up to the error.

Understanding the requirements which built the basis for the error and unsafety is needed. To do so one must access every part of the system and how it is affected or can affect other systems. Human errors are just symptoms that are visible (Woods et al., 2010).

The variability of everyday life needs to be considered and this variability helps to form a safer system. Cook & Rasmussen (2005) describe in their model "going solid" how important the understanding of the system is and what happens if errors are just seen as linear results of a single cause.

Varied factors contribute to safety and play a role in a proper assessment of the risk. Utilizing systemic, contributing, and direct factors helps to get a holistic overview of what is important (Leveson, 2012).

As the focus shifts to more proactivity an iterative process of which adjusts protocols all the time towards the current conditions is needed. The variability in performance has to be altered to match acceptable outcomes (Hollnagel, 2012).

This variability shows how work really is done instead of trying to imagine what could happen in various situations. As the complexity increases the need for a safety management system increases as well.

3.3. Safety Management Systems (SMS)

The implementation of a safety management system is important to gather all the needed information to implement an effective safety culture (Li & Guldenmund, 2018). All information gathered inside the system shall guarantee safety for internal and external factors included. Those can vary from employees and infrastructure to the environment (Akselsson, 2019). Safety management is a comprehensive system determining how safety can be reached by using different efforts and needs which define safety requirements (Li & Guldenmund, 2018).

Within the SMS different responsibilities have to be distributed to achieve continuously improving safety (*Safety Management System | Federal Aviation Administration*). Those can be divided into the stages of the evolution of an SMS.

The first part is policies. Those policies define methods and processes which are needed to standardize certain aspects of safety. Examples of this can be the machinery directive 2006/42/EC, the Directive for Use of Equipment 2009/104/EC, and the systematic work environment management AFS 2011:1 by the Swedish work environment authority. As the policies show a commitment in the upper level of the company to improving safety continuously. The resulting safety culture includes shared values and attitudes from the organizational level all the way down to the individual level (Akselsson, 2019).

Building upon policies one must define safety risk management. Safety risk management includes different aspects of the company starting with initial hazards which can lead up to risks and thereby including the identification of the risk, an appropriate analysis, and control mechanisms for the risk (*Safety Management System | Federal Aviation Administration*).

For the company, it is important to make sure that safety assurances that evaluate and contribute insights to future risk assessments. Increasing complexity shapes the need for more thorough compliance with directives. Li & Guldenmund (2018) describe the indication of the use of SMS and propose that the use always will change over time. Using a controlling tool for the implemented safety assurances as the PDCA cycle is one way to do that. Plan, Do, Check, and Act help to systematically assure a safe work environment. Including the workers in making sure that a regular evaluation is used for safety promotion.

Although safety promotion is a result of the SMS, it is also part of it. When using SMS, the primary purpose should be safety promotion. Clarifying that the result is part of the solutions is crucial for introducing safety II thinking as well.

The different elements of the SMS can as well be described as part of the life of the risk. Starting with the birth, when a risk is named for the first time until the risk leads up to an incident. During this journey, different barriers are in place to make sure that the risk is mitigated and resolved even before an incident occurs.

4. Leadership and safety culture

As mentioned earlier in the safety management system part, safety promotion is important to reduce the risk of getting a severe incident. Due to the legislation AFS 2001:1 (SAM), one of the main responsibilities of the employers lies in preventing accidents. On part of this can be to implement activities aiming to promote a safety culture, which is part of the leadership in the company.

As the company gets bigger it gets harder for the people on top to control every step of the implementation of the safety culture. To delegate people one must assume different levels, such as the leader or organizational-, group-, and individual level. Dividing the system into those levels will help to sort different tasks and responsibilities (Nielsen & Noblet, 2018).

To make sure that the legislation is implemented the right way, starting from the top with the organization. Establishing a safety culture from the beginning helps to mitigate misunderstanding and miscommunication from the start (Dellve & Eriksson, 2016).

Wang et al. (2022) mention the factor of the management paying attention to the safety culture as one important part of the factors which can influence the safety culture. As paying attention is regulated by the AFS 2001:1, clear communication with the employees is needed. Clear communication gives the management and the employees sufficient information on how to carry out safe work and prevent ill health at the same time (Dellve & Eriksson, 2016).

Effective communication can be used to mitigate active failures such as slips, lapses, and mistakes while at the same time shortening the time of risks being discovered (Dellve & Eriksson, 2017; Reason, 1990).

The commitment of the management is the starting point of the safety culture (Leveson, 2012).

Leading by example is showing how to set up good behaviors inside the team. The team will benefit from the clarity of responsibilities and open communication (Wheelan, 2009).

Making sure that the right culture is established will as well need proper team management for the right work environment. The group level is important to implement norms and standards, which will strengthen the relations among workers and improve the feeling of security (Lennéer-Axelson & Thylefors, 2005).

Good leadership raises the awareness of clear communication and mitigates thereby the misinterpretation (Natalia et al., 2015).

5. Methods

The following chapter describes the methods used in this thesis.

Every method used will be described briefly to show how the aim of this thesis is to map the main reasons why legal requirements such as the machinery directive (2006/42/EC), the use of work equipment (2009/104/EC), and SAM (AFS 2001:1) are not sufficient in preventing health and safety risks from traveling through a system from traveling after they've been made conscious for stakeholders at the workplace", could be answered.

The goal for the thesis was to get as much input as possible from the interviewed persons to gather many different insights on how they view safety and see the risk. As I´m looking at "Behind the human error" this will play a significant role in determining the results and give recommendations inside the conclusion.

As the thesis is written in cooperation with AFRY, the author was dependent on which data could be used from the company. A continuous dialogue helped to find the most suitable material which than was used for writing this thesis.

I decided to keep the quotes and ABRA examples in the original language, Swedish. According to me important word could lose emphasis by a more subjective and "content correct" translation. Some parts of the quotes are marked in black. This is due to secrecy of the involved stakeholders.

5.1. Study Design

The study design used is multiple case studies of different industries chosen by the company and me together. The goal was to find cases/ persons that would be able to describe different kinds of risks from different perspectives, explore real-life examples, and try to use scientific theory to answer the research questions (Darke & Shanks, 2002).

Using multiple case studies enabled me to test different theories on why legal requirements aren't enough to prevent risks from continuous traveling (Darke & Shanks, 2002). The mixture of interviews and analyzing already existing documents built the foundation for my approach to gathering all needed insights (Simons, 2009).

Mixed methods were used as a research technique where both quantitative and qualitative measurements were collected. By using this kind of triangulation the goals were to increase the validity of the findings for giving a more general and objective result (Jick, 1979). On the one hand, I used the triangulation of two different methods with qualitative and quantitative measurements, and on the other hand, different theory's and models as a basis for answering the research question (Heath, 2015). The use of different methods helps to mimic the variance of reality in the scientific setting of this master's thesis.

5.2. Data collection

Data collection was done in four interviews. The chosen interviewed people were all part of the company and had experience in handling safety and risk management.

Besides conducting the interviews, I used two already existing risk analysis from the company. Those risk analyses were conducted to the ABRA principle. ABRA stands for "activity-based risk assessment" and is a common way for the company to assess the risk for different processes.

ABRA is an inhouse tool by AFRY for risk assessment at different working places. It consists of an excel template where different risks are documented and divided into health, safety, and environmental risks. The risks are assessed through a in person company visit and questions such as Who, How, and What are answered. Those give a numerical value based on a risk matrix. The risk matrix assesses a risk by its probability and seriousness. The ABRA is conducted by AFRY´s consultant trained with this method.

Common themes found in the interviews were cross-referenced with the risk analysis. That helped to gain a broad overview to answer the research question (Williamson, 2002). More details to this process are described further on.

5.3. Semi-structured interviews and questionnaire

The questionnaire used is a combination of different. This could provide me with the broadest results possible throughout the data gathering process (Darke & Shanks, 2002).

One part is the COPSOQ questionnaire (COPSOQ, 2021).

Items I used are part of the "Role clarity" (RC) category and the "cognitive demands" (CD) category. Those four questions included:

1. Do you have to keep your eyes on lots of things while you work? (CD)
2. Does your work have clear objectives? (CD)
3. Do you know exactly which areas are your responsibility? (RC)
4. Do you know exactly what is expected of you at work? (RC)

The questions were asked at the end of each interview for making sure that personal bias is as small as possible. None of the answers were used in the results section, due to too big inconsistencies.

Another part of the questionnaire is retrieved of the working material for sustainable leadership by Dellve & Eriksson (2016, p. 44). Using this material gave a macro perspective on how people working with risk and safety issues. By addressing those it helped to investigate the causes of why legal requirements are not enough.

The questions used are retrieved from Exercise D: Finding risk factors (p. 44). In total were seven questions used in the interviews. Those could be answered with a numerical value from 0=no problem, 5= moderate problem to 10= severe problem.

Following the seven questions how they were asked during the interviews, with the Swedish translation:

Table 1 Interview question retrieved from Dellve & Eriksson, 2016

Item	Risk factor	Rank 0-10
1	High Work pace- time pressure/ Hög arbetsbelastning – tidspress	
2	Difficult/ complex tasks / Svåra/ komplexa arbetsuppgifter	
3	Working alone / Ensamt arbete	
4	Unclear communication/ Otydlig kommunikation	
5	Constant changes / Ständig förändring	
6	Information overflow/ Överflödig information	
7	Insufficient knowledge of machinery/ Otillräcklig kunskap av machiner	

The compendium of questions was concluded by the questionnaire from the Health and Safety Executive (HSE) of Britain's national regulator for workplace health and safety (Health and safety executive of Britain, 2023).

The whole questionnaire used during the interviews can be found in appendix 1.

Combining various parts of different questionnaires, where the questions are open, enables the interviewed person to express their thoughts freely. It will allow the respondents to formulate their thoughts outside of rigid frames and enable them to express their personal experiences (Williamson, 2002). The semi-structure allows me to deepen some thoughts throughout the interview time and captures the perspective of the respondent (Williamson, 2002)

All interviews were transcribed with the word "dictating" function.

Before the interview, all people were informed about the purpose and that they do not have to answer the questions if they don't want to. As they all are part of the company, and I signed a non-disclosure agreement, no further agreement had to be signed. Everything in the interviews is anonymized for safety reasons.

Important to mention that the four interviewed persons were one female and three males. All four persons are employed by AFRY and work on various levels inside the company.

The abbreviations used in Table 3 are shown in the following figure 7 in a hierarchical way:

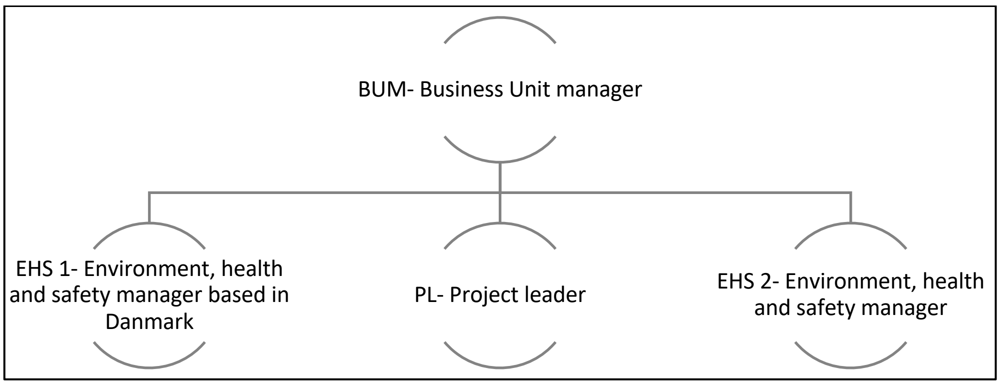

Figure 7 Hierarchical structure interviewed persons, Eff (2023)

5.4. Literature research

One part of the information gathering was due to literature research. Different search strategies were used as shown in the table 2 below. Those strategies helped to scale down the amount of information. At the same time it helped to find more fitting literatre.

Table 2 Search Methodology

Search Term	Search Engine	Hits	Narrowed by	New hits
proactive AND (risk OR exposure OR hazard) AND (mitigation OR reduction OR remission)	Web of science	1384 hits	Citation topics meso "Safety and Maintenance" --> sort by Usage (all time): most first	40
Resilience AND OSH	PRIMO			19
"Change management" AND organization AND safety	Web of Science	102	Citation topics meso "Safety and Maintenance" --> sort by Usage (all time): most first	13
"Swiss cheese" AND risk AND barrier*	Web of Science			11
systematiskt arbetsmiljöarbete AND (Risk OR Säkerhet)	PRIMO			7
leadership AND safe* AND (risk management) AND legislative	Web of Science			5
safety culture AND leadership AND (risk management)	Web of Science	141	Citation Topics Meso: Safety & Maintenance (58 hits) Quick Filters: Highly cited papers review article	 1 5

After reviewing the search findings through reading the abstract a combination of those and course literature was used to build the scientific background and theoretical framework of this thesis.

5.5. Combination of the semi structured interviews and the ABRA method

The following chapter will describe how the different methods were combined and lead up to the findings.

Starting out with the literature research, where the purpose was to get an overview on which literature is available for the theme of the thesis and at the same time trying to limit the scope.

Followed by that the generation of the interview guide (appendix 2) the interviews were conducted and transcribed. During this process it got obvious that the table used from Dellve & Eriksson (2016) generated numerical values which could be analyzed. This led to a statistical analysis where the highest ranked values built the foundation for the analysis of the text from the interviews.

That enabled an analysis of the same themes throughout the four conducted interviews as seen in table 5.

In table 6 different examples of the ABRA templates are shown. The identified risks could be divided then into common causes which then were divided into the highest valued themes identified from the table of Dellve & Eriksson (2016).

This made it possible to cross-reference the conducted interviews with the ABRA templates done from AFRY.

6. Reporting of results

This chapter will include the results of the four semi-structured interviews and two risk assessments done by the company. The result section will include the most common themes found in the interviews and the risk assessments.

The analyzed interviews and ABRA show that both insufficient knowledge and unclear communication, are two of the main reasons leading to a continuous travel of risk.

6.1. Interviews table questions

The seven items shown in the table were answered with a numerical score of 0-no problems, 5- moderate problems up to 10-severe problems. Those values were used to calculate the mean, median and range.

The following table 3 shows the results in a table divided by the used interview questions:

Table 3 Risk factors by Dellve & Eriksson 2016

Item	Risk factor	Mean values	Median	Range
1	High Work pace/ time pressure/ Hög arbetsbelastning – tidspress	5,25	5,5	6
2	Difficult/ complex tasks / Svåra/ komplexa arbetsuppgifter	4,25	4,5	2
3	Working alone / Ensamt arbete	4,5	5	8
4	Unclear communication/ Otydlig kommunikation	5,5	7	8
5	Constant changes / Ständig förändring	4	4	8
6	Information overflow/ Överflödig information	3	3,5	5
7	Insufficient knowledge / Otillräcklig kunskap	7,75	8	1

Further statistical analysis conducted with the values calculated in the median and range are not further discussed, because of the low amount of low number of values in general.

The highest mean and median values were reached by items 1, 4, and 7. I defined the highest value as a value above the median which is 5.

For item 1 with too high work pace/ time pressure, the average was at 5,25 and thereby the third highest value

“Unclear communication” (Item 4) reaches 5,5 on average and is thereby the second highest-ranked risk factor. Item 4 is exceeded by 2,25 points to 7,75 with item 7 “Insufficient knowledge”.

The lowest ranked item 5 “constant changes” and 6 “information overflow” averaged 4 and 3 points.

When looking at the range one can see that item 7 has the smallest range with 1. The other ranges are high. This will be discussed more in the part methods discussion.

6.2. Interviews open questions

The transcribed interviews were analyzed by using the two items with the highest value. Those are item 4 unclear communication/otydligt kommunikation and item 7 insufficient knowledge/ otillräckligt kunskap.

The third highest item 1 was not used for further analysis because of a lack of information/ mentions inside the interviews.

The following table 4 presents the results of the analysis. The focus was to identify different formulations which can then be put into frequencies and build an average.

Table 4 Results analysis

ITEM	EHS2	PL	EHS1	BUM	Average frequencies
4 unclear communication/otydligt kommunikation	6	8	5	4	6
7 insufficient knowledge/ otillräckligt kunskap	12	9	6	11	9,25

Insufficient knowledge/ otillräckligt kunskap is mentioned 3,5 times more often on average across the four conducted interviews with 9,5 mentions.

Unclear communication/ otillräckligt kunskap is mentioned on average 6 times throughout all interviews.

The following table 5 shows examples of how the quotes were coded. The entire analysis is found in appendix 3.

Table 5 Interview Coding

Quote	Item/Theme	Person
But sometimes it turns out to be the opposite direction because I wanted out another piece	Unclear communication	EHS2
Therefore, the fence got lowered with the primary argument that it would be easier for the ergonomics… to 90 centimeters…	Insufficient knowledge	EHS2
Problemet är ju ofta kommunikation. Så man har en idé om det här som kan vara en risk. Det här kanske är en risk men det är inte så många som vet om det för de har inte varit på byggarbetsplatsen och jobbat.	Unclear communication Insufficient knowledge	PL
They don't know, what they don't know, so their truth	Insufficient knowledge	EHS
Och då finns det ju risk att man gör den där ändringen efteråt och då kommer det liksom inte med i grunden projektet, vilket gör att det inte är säkert att du samlar dokumentationen på ett bra sätt. Vilket gör att du har en risk, men du tror att du inte har en risk.	Insufficient knowledge	BUM

6.3. Risk assessments

The risk assessment from the company was conducted through a method called ABRA- activity-based risk assessment. For the analysis, the focus was to see the amount of risk inside the different fields of health, safety, and environment.

As the risk assessments provided by AFRY hold confidential material examples are anonymized but kept in the original language.

In total two risk assessments could be used resulting in a total of 38 risks for health, 85 risks for safety, and two risks for environment.

Typical examples of health risk can be the lifting of an item to another spot, where bad ergonomically positions happen, or during maintenance when the spots to reach require un-ergonomically positions.

Safety-related risks can be exemplified by maintenance work where loose parts can harm the operator through a pinching injury or when using tools overhead that might not be anchored as they should be .Being able to analyze common themes around the risk had to be named and coded as well, which can be found in the following table. The analysis was done by using common themes across the two ABRA templates.

The following table shows examples of the two different ABRAs investigated:

Table 6 Examples Analysis of the ABRA templates provided by the company

Risk identification	Example from the ABRA done by AFRY	Cause
Tight space for working	Operatör skall lyfta upp bultar till flänsringen som finns nederst i hissen (undre del av palletställning). Operatör slår i huvudet alt. skadar ryggen då utrymmet är trångt	Design, misuse
Miss placement of tools/ machinery	Lyftredskap saknar korrekt märkning/ angivelse för raka lyft, finns enbart angivelser för lyft 0-45º samt 45-65º. Vid lyft med 90º arbetsvinkel (eller ex. 1 part) saknas angivelse för max vikt och operatör kan överbelasta part/lyftredskap och ger vika.	Understanding of directives/ User manuals
Clarity of different working stations	Då arbete i donet skall utföras placerar operatör en stötta som paneldörren till donet ska vila på. Då operatör placerat paneldörren ger stöttan vika alt. att stöttan är felplacerad och paneldörren alt. hela donet åker ner och träffar operatör	Organization/ Management
Planning of work/ working processes	Operatör behöver använda olika typer av verktyg för att montera på tätprovningsadapter, Hen har ingen avställningsyta och måste lägga verktyg på golvet alt. hålla båda i händerna eller klämda de mellan benen. Operatör tappar verktyget alt. snubblar på verktyg.	Not involving workers in the process
Contact with chemical hazards	Operatör transporterar gasflaskan till produkten för att utföra läcksökning, hen kör på kringutrustning och glasflaska kommer i rörelse och faller. Alt att gasflaska faller till följd av kraftig rörelse/svängning centrifugalkraft)	Planning of working processes
Working alone	När röret har förts in till c:a 60-80% förser enbart 1 operatör den resterande biten. Ju längre in röret kommer ju mer tyngre blir det och operatör får tillfoga mer kraft. Sista biten av momentet får operatör använda hela kroppen för att få in röret helt. Operatör belastar hela kroppen negativ i detta moment.	Planning of work in general

Those six different causes can be summarized in the categories used in the semi-structured interviews.

Unclear communication can be broken down to

- design/misuse
- organization/management,
- planning of working processes.

Whereas insufficient knowledge includes

- understanding of directives/user manuals,

- not involving workers in the process
- the planning of work in general.

7. Analysis and interpretation

The following part is dedicated to the analysis of the data presented above and how this relates to the aim of this thesis.

7.1. Unclear communication

Clear communication and the ability to pass the information along are crucial for the identification and follow-up of risks by using a systematic approach as a safety management system(Reason, 1990).

The first interviewed EHS (environment-health-safety)- manager said that:

"*Because sometimes it turns out to be the opposite directions because I wanted out another piece."*

It is possible to see one thing in two separate ways depending on prior knowledge. The cognitive processes of bottom-up and top-down will in this case dictate how the result of something is interpreted (Osvalder & Ulvengren, 2019). While unique experience among personnel is just one problem, the ability to use the legal requirements the right way is also important. When looking at the machinery directive and the ability to use it is difficult as the EHS stated by

"Like it's hard to make sure that someone understood it. To the point where someone did it wrong."

One is talking about communication from person to person and the communication evolving out of reading instructions. The legal text might be clear in the formulations to the persons who wrote them but may be unclear to a person who use them. It is easy to fall into slips as a passive way to fail when someone misses important information through inattention or a flaw in communication (Norman, 2013).

Being able to see those flaws inside the sociotechnical system led to the integration of safety II. As before stated, is safety II the ability to look beyond the regular errors and see what is leading up to those.

Thereby clear communication plays a crucial role:

"Så tror jag att den här förvirringen mellan vilken [redacted] *som skulle vara det beror mest bara på alltså på att de kanske inte är* [redacted] *som var med från början. Jag har ju pratat med* [redacted] *kollega* [redacted] *först så jag tror att det kanske antingen så har* [redacted] *missuppfattat mig och meddelade* [redacted] *eller har* [redacted] *och missuppfattar* [redacted] *alltså det har blivit en missuppfattning."*

Misunderstandings are normal and based on the cognitive processes mentioned earlier (Osvalder & Ulvengren, 2019).

This becomes even more important the more complex the systems get (Leveson, 2012). See the various parts inside the system will help to gain needed information for setting up risk-mitigating procedures.

Seeing the human subsystem as a basis is one part:

"They believe they know what happens and because they know what happens, they believe they have it under control".

The problem of hindsight bias mentioned in Leveson (2012) points toward the importance to communicate clearly from the beginning to elaborate on different scenarios as it is stated as well by the PL:

"*Kommunikation emellan de olika aktörer skulle också gynnas av att ha helt enkelt oftare möten."*

Clearer communication from the beginning of a project is key to success in avoiding hindsight bias. The earlier in the process this will be reached the better for both economic and safety concerns (Winch, 2009).

Despite gathering the knowledge while working on a project one of the EHS suggested:

"Share that knowledge with our mother company, so that this will give us the credit and the honor of finding new risks. This will make us in good standing with the other company."

This type of shared knowledge is in need of a clear leadership and safety culture to be effective (Wang et al., 2022). Committing to this shared knowledge approach will help to spread safer processes and the awareness of risks (Leveson, 2012). Not only does this kind of communication affect safety but also increases the awareness of that sufficient knowledge is needed.

7.2. Insufficient knowledge

During the interviews “insufficient” was mentioned more often on average. This tells us how important it is to have sufficient knowledge for being able to find, admit and in the end mitigate risks. As were are talking about insufficient knowledge one can see that the lack of it contributes to more unsafe behavior (Wang et al., 2022).

Gathering enough knowledge is not just about knowing something. It is as well crucial to understand it and know how to use it in practice. Looking back at the legal requirements in the form of the machinery directive, Jespen (2016) mentions the safety-by-design approach. This approach is possible when sharing knowledge. Exemplified by a statement of the EHS:

“To the company and they agreed on it [legal requirements in general], and there's it's legal according to the Machinery Directive, but the machine or directly doesn't say anything about heights of pins. It only says that you need to work, make it safe, and then you need to base it on standards. So, if they were referring to the machinery directory as an answer, then they're referring wrong. If they're referring wrong, they don't know what they're referential. I don't know what they prefer. Then they don't understand it.”

While it is not just the knowledge itself but the administration inside the sociotechnical system. Wilson (2014) emphasizes understanding the system in its complexity.

Knowledge is the accumulation of both the bottom-up and top-down processes mentioned by Osvalder & Ulvengren (2019). As this knowledge is still too complex for analyzing putting it into the subsystems of humans, technology, and organization enables us to see the bigger picture clearer (Eklund, 2003).

The human perspective mirrors the knowledge itself. To quote it with the EHS:

“They don't know, what they don't know, so their truth”

As humans remain the most complex part of a system, making sure that a base of knowledge is provided amongst everyone to install safety. At the same time, the interrelation with technology is crucial for that.

This is working in two directions. On the one hand, sufficient knowledge among the personnel about the technology is needed, as said by the PL:

"…*att det beror på att man kanske inte vet så mycket om området när man börjar arbetet och sen lägger till. Sen kan det också vara i ett annat projekt jag jobbade i, där när det kommer nya det är många olika aktörer som tänker olika."*

On the other hand, the design of the technology should be promoting safety and health (Norman, 2013). Finding the risk by using this systematic approach needs an organization that can facilitate that and is able to see this in a holistic way. As the following example states it is not always the case:

"*They asked for help with the CE marking which they were clearly assessing as being a minor formality in the big picture. As they had put together a perfectly safe working system which works running at the time being when I visit them. So therefore, it was considered a formality just to put on the official assessment and confirm that what we did is safe and that means in hindsight the end of the activity seen. We were pulled in too late."*

This highlights a lack of safety culture where all the different components are pulled together. Looking at the Risk identification model provided in Chapter 3.4. one can see how the risk evolves out of the different parts of the HTO model in figure 8

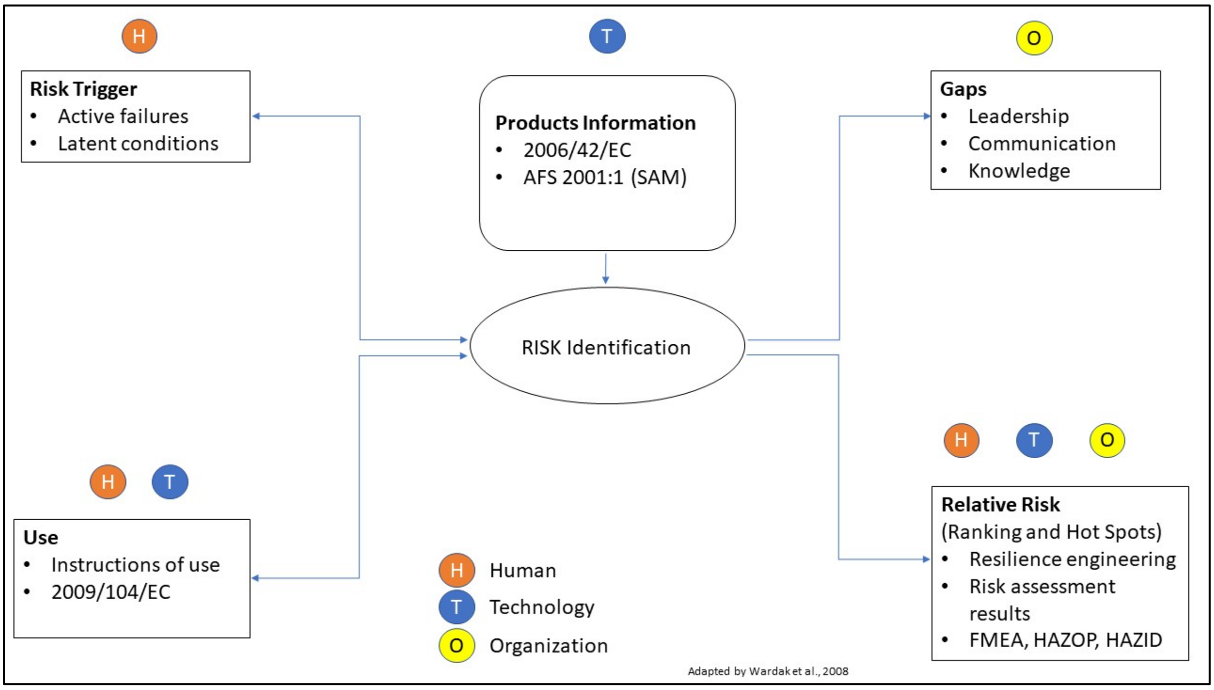

Figure 8 Risk Identification framework with HTO perspective adapted by Wardak et al., 2008

Not only does this framework describe how risk is generated by various parts of a system but as well how the HTO framework can be implemented in here.

7.3. Risk Assessment and Interviews

While using different models from science the need for a more practical approach is still present. Using the themes from the interviews with unclear communication and insufficient knowledge and incorporating them with actual risk assessments will give a more in-depth understanding of why risk is still a risk after it's been made conscious.

While communication and knowledge mentioned earlier are important for the risk identification it may be hard to imagine how it will look like in practice. The following example shows how a lack of communication between personnel and thereby the lack of knowledge contributes to bad design which in this case may lead to safety and health issues:

"HUR: Operatör skall lyfta upp bultar till flänsringen som finns nederst i hissen (undre del av palletställning). Operatör slår i huvudet alt. skadar ryggen då utrymmet är trångt".

As mentioned before is the design part of the whole safety process as it incorporates different parts such as humans and technology (Eklund, 2003; Norman, 2013).

Those can for example be *”Problemet är ju ofta kommunikation. Så man har en idé om det här som kan vara en risk. Det här kanske är en risk men det är inte så många som vet om det för de har inte varit på byggarbetsplatsen och jobbat.”*

This fact aligns as well with the following quote:

” So, in combination with a basic understanding of the basic principle in machinery safety. Nobody asked them if they knew enough, or if they had the right knowledge because they either got confirmed they had the right knowledge indirectly by asking others who were stating that they knew what was right or wrong. And then also it got blurred by the basic understanding.”

As the design is followed by the planning phase an early incorporation and communication of the workers can help to mitigate the risk right away (Winch, 2009).

Looking back the aim where the question refers to why the legal requirements in place aren’t enough, the result shows that unclear communication and insufficient knowledge are two of the main reasons. The results point clearly towards those flaws especially and thereby can answer the question within the aim of this thesis.

8. Discussion

The discussion will include a comparison of the theoretical framework laid down in the beginning and pull the results in context to those. A methods discussion will as well take place at the end of this chapter.

8.1. Why the legal safeguards are not enough - Knowledge makes safety

The legal requirement mentioned in the background such as the machinery directive (2006/42/EC), the use of work equipment (2009/104/EC), and SAM (AFS 2001:1) is well-formulated legal texts/ recommendations. They describe in a thorough way how to accommodate equipment, how to use equipment, and how to implement everything together in a good workplace. Focusing on many things at the same time can be problematic from different points. As mentioned by Osvalder & Ulvengren (2019) different cognitive processes influence the perception of the human. Designing a sociotechnical system with a human-centered focus increases the complexity while at the same time trying to solve the problem of insufficient knowledge (Nord Nilsson & Vänje, 2018). As seen in the results section “insufficient knowledge” is the main reason the risk continues to exist, even when one is conscious about it.

The complexity of incorporating the different legal requirements/ recommendations is one part of the solution. Making sure that personnel can understand the key message built the basis.

Throughout the analyzed risk assessment one can see that knowledge about the systems and how everything works raises awareness and at the same time increases the level of certainty (Akselsson, 2019).

The legal requirements in the end have been implemented and for doing that it is necessary to use the knowledge provided by them.

In the following a graph showing how the interrelations between the subsystems of HTO can be used for analyzing the problem of insufficient knowledge.

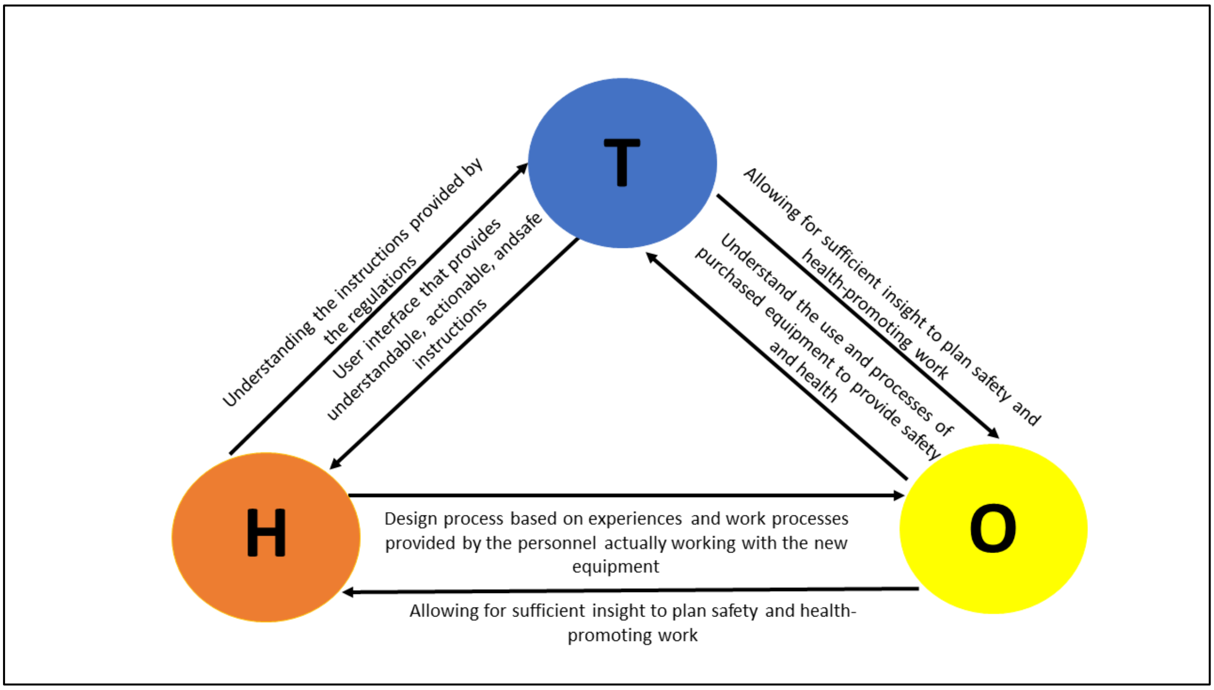

Figure 9 Insufficient knowledge integrated into the HTO- model by Eff (2023)

As figure 9 shows, the interrelations describe why knowledge is such a powerful tool for enhancing safety and mitigating risk.

The human often is the blunt end in the decision-making process which leads to missed opportunities in the knowledge-gathering process. At the same time, the human is the first responder to the actual risk.

Using the risk identification framework gaps used to identify are leadership, communication, and knowledge (Wardak et al., 2008). The model used above highlights the importance of the different steps that must be considered for giving reliable assumptions on which kind of knowledge is needed.

Risk triggers can be active failures or latent conditions and can be seen as part of insufficient knowledge (Osvalder & Ulvengren, 2019). In the model, the described interrelation between the human and organization sub-system is insufficient knowledge supplied either by the user or the organization which leads to the ongoing existence of the risk. Mitigation can only then be done when enough knowledge is provided to analyze the situation inside the sociotechnical systems and make it thereby accessible (Wilson, 2014)

Thereby one can assume that enough knowledge will provide tools for mitigating the risk by increasing the awareness of the complexity inside the sociotechnical system (Leveson, 2012)

8.2. Using Communications as a risk mitigator

As mentioned in the risk identification framework communication plays a significant role in mitigating the gaps of uncertainty.

When communicating between different subsystems it is important to have the human in mind. The design needs must be communicated by the human to the technology and the organization. The findings of the analysis show that unclear communication often leads to wrong design.

Communication can be done in a lot of different ways. Osvalder & Ulvengren (2019) mention the importance of redundancy for information. Different people understand the information in a unique way. Making sure that the right information needed for reducing the risk is understood should be the most important goal.

The following figure 10 shows the ways of communication and where interventions are needed to mitigate the risk.

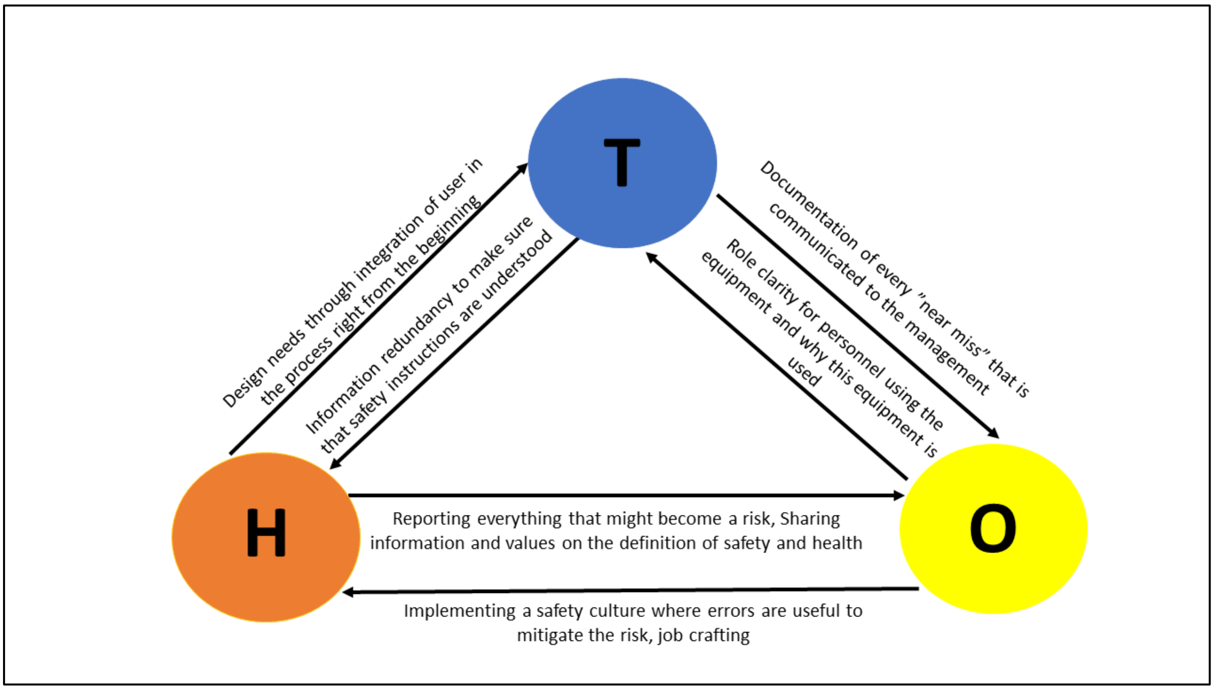

Figure 10 Unclear communication integrated in the HTO- model by Eff (2023)

Clear communication comes down to implementing a safety culture where everything that might be a risk is communicated (Dellve & Eriksson, 2016). Increasing the rate of understanding through clear communication shortens the time for the personnel to react and helps to mitigate the risk (Reason, 1990).

To reach safety everyone must follow the plan, do, check, act cycle. Throughout the different stages it is mandatory to communicate in a clear way and implement that in the end in the SMS (Li & Guldenmund, 2018). Implemented in the everyday work, the SMS will help to keep track and facilitate communication as a risk mitigator.

8.3. Methods discussion

The methods used in this thesis are based on interviews conducted with AFRY employees and ABRA done as well by AFRY.

Important to discuss are the result under consideration of the Hill criteria for causality. There are nine different criteria to discuss (Fedak et al., 2015). The result seen from the interviews can be seen as consistent since different people, came to the same conclusion. At the same time, one must be cautious with the strength of the association. Other causes such as lack of staffing, the kind of industry, or even the amount of people involved in general play a role in why the legal requirements are not enough.

Evidence found in this thesis suggests that a general lack of clear communication and insufficient knowledge. Specificity could not be proved towards a project or part of industry.

The results of the thesis would have been more specific with focus groups or even cohort studies across all units of AFRY across the world or at least inside one business unit in Europe.

A greater validity and reliability of the result could have been achieved by a bigger amount of data. From persons interviewed but as well the proved ABRA from AFRY.

Looking at the range, there is an inconsistency among the four persons interviewed. That could be explained by either their personal experiences, their roles (where they are in the hierarchy), or their own perception.

Interesting as well to mention is the inequality between genders inside the interviewed persons. With three men and one woman, there could be a bias. Although assuming an equal distribution this would be one thing to consider when redoing the interviews.

Having the four interviews distributed across two countries (Denmark and Sweden) can as well play a role in different views and culture on risk assessment and safety in general.

9. Conclusion

As the aim of this thesis is "to map the main reasons why legal requirements such as the machinery directive (2006/42/EC), the use of work equipment (2009/104/EC), and SAM (AFS 2001:1) are not sufficient in preventing health and safety risks for the users from traveling through a system from traveling after they've been made conscious for stakeholders at the workplace", it is not possible to answer with certainty due to a lack of sufficient data.

Data gathered from the study shows that risk travel can be caused by both insufficient knowledge and unclear communication, though the amount of data is insufficient to prove that these are the main causes. Further research would be needed to show clear evidence.

In this thesis, the HTO model was used as a tool to help investigate the causes of ongoing risk travel. Analyzing the human factor, technology, and company organization through this tool made it possible to give suggestions to improve future risk assessments.

9.1. Risk communication

The field of risk communication can be used to find the best possible strategy for risk mitigation. Having the right team at the right time in the right place is just one part. As seen through the interviews and risk assessment, communication between different personnel plays a significant role.

Especially when talking about risk it is important to communicate in an efficient way that everyone understands how serious it is. Risk communication applies not to every part of a process, but it needs to be one of the first parts to be mentioned and analyzed.

9.2. Resilience engineering

Resilience engineering is an emerging field that can be a remarkable success when used properly. It can be a complement to the legal requirements that are already in place.

Engineering a system, in a way that adequate safety boundaries, such as clear communication and sufficient knowledge are important. As a first instance, those two characteristics will help to understand how risk can proactively be mitigated from the beginning. Cook & Rasmussen's (2005) model of going solid might be worth incorporating into the resilience engineering as it demonstrates a clear picture on what will happen when boundaries are crossed and resilience is not given anymore (Hollnagel, 2017).

The concept of resilience engineering gets even more interesting at the point where one have the dynamics of the socio-technical systems and want to foresee as adequate as possible risks that might occur and can harm personnel in the end.

Not only does this keep people safe but can also safe money in cases where a risk slipped through all boundaries and led to incidents/ accidents.

9.3. Recommendations

Recommendations can include the building of checklists that can be used by the personnel and the management to make sure that risks are understood the same way throughout the company.

Increasing the communication and knowledge will help to understand where in the process the risk is made conscious and when to proactively intervene.

As seen in the discussion a thorough understanding of the subsystems which are part of any risk, and analysis of the processes inside this frame may help to see the interrelations mentioned earlier and thereby prevent the risk from further traveling.

Other suggestions could include reconsidering when and why the ABRA is used. To my knowledge, a clear differentiation between “safety” and “health” risks isn’t written in stone. The personnel using ABRA could receive help from a clearer difference that the categorization of risks is more objective to everyone using the template or is working with an already conducted ABRA.

Overall, it is important to emphasize that no matter how evolved the used technology is, human is and will always be the most important part of it.

Taking care of human safety by increasing their knowledge about the risks and improving communication among everyone will be crucial to increase the corporate overall health.

The need of a “political reflective Navigator” defined by Broberg & Hermund (2004) is according to me an important role to consider in every company. As a “political reflective navigator” one could have knowledge across different laws laws and regulations, being able to reflect from the view of different involved stakeholders and navigating everything in complex systems and processes. This should be part of almost every organization.

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Appendix 1- Entire questionnaire

Hi and welcome to my interview for my master's thesis here at AFRY. I'm doing my master's in technology, work, and health at the KTH and would like to ask you some questions about risk and safety at work.

At any time, you can quit the interview. You do not have to answer if you don't want to. Everything used in the interview will be anonymized.

Do you have any questions?

1. Who took part in the safety planning process of the working site?
   a. Vem deltog i säkerhetsplaneringen på arbetsplatsen?
2. Did you place the elevator on purpose at that position?
   a. Har ni medvetet placerat hissen i denna position?
      i. Did the chosen risk assessment suggest placing the elevator where it is right now?? (What was first?)
      ii. Är det riskbedömningen som varit avgörande för vart hissen ska placeras?
3. Did you check, understood, and knew how to interpret the legal requirements (e.g., machinery directive, SAM) in case of the installation of the new working site?
   a. Har ni checkat, förstått och vetat hur ni använda lagkrav såsom minimikrav för säkerhet och hälsa vid arbetstagares användning av arbetsutrustning i arbetet och SAM, när ni planerade den nya arbetsplatsen?
4. How does the evaluation of the risk assessment look like?
   a. Hur utvärderar ni en riskbedömning?
5. Do your employees receive introduction and/or safety training before undertaking work tasks? If so, please enclose details of training courses undertaken by staff.
   a. Får dina anställda/ kollegor/ du en introduktion i säkerhetsträning innan dem börjar jobba på arbetsplatsen? Om ja, vilka?
6. How do you provide enough information for the workers to pursue safety at work? (e.g., how do you make sure that everybody in the project involved understood legal requirements concerning safety?)
   a. Hur förser du dina kollegor med tillräcklig information om hur man arbetar säkert? (Säkerställer att alla är införstådda gällande lagkrav och liknande för säkerheten.

Amount	Risk factor	Rank 0-10
1	High Work pace- time pressure/ Hög arbetsbelastning – tidspress	
2	Difficult/ complex tasks / Svåra/ komplexa arbetsuppgifter	
3	Working alone / Ensamt arbete	
4	Unclear communication/ Otydlig kommunikation	
5	Constant changes / Ständig förändring	
6	Information overflow/ Överflödig information	
7	Insufficient knowledge / Otillräcklig kunskap	

0 = no problems/ inga problem

5 = moderate problems/ måttliga problem

10 = Severe problems/ allvarliga problem

1. Do you have to keep your eyes on lots of things while you work?
   a. Behöver du ha koll på många saker samtidigt när du jobbar?
2. Does your work have clear objectives?
   a. Har du tydliga arbetsmål?
3. Do you know exactly which areas are your responsibility?
   a. Vet du exakt vad som är dina ansvarsområden?
4. Do you know exactly what is expected of you at work?
   a. Vet du vad som förväntas av dig på jobbet?

Appendix 2– Interview analysis

Quote	Item/Theme	Person
But sometimes it turns out to be the opposite directions because I wanted out another piece	Unclear communication	EHS2
Therefore, the fence got lowered with the primary argument that it would be easier for the ergonomics… to 90 centimeters…	Insufficient knowledge	EHS2
OK, no, it's 15 kilos. It's below yellow, so it's or it's below the red line here. So it's legal.	Insufficient knowledge	EHS2
And then I said yeah, but how do you lift it? They said, oh, it's legal to lift, yeah, but where are you lifting it? But it's legal according to law.	Unclear communication Insufficient knowledge	EHS2
To the company and they agreed on it [legal requirements in general], and there's it's legal according to the Machinery Directive, but the machine or directly doesn't say anything about heights of pins. It only says that you need to work, make it safe, and then you need to base it on standards. So if they were referring to the machinery directory as an answer, then they're referring wrong. If they're referring wrong, they don't know what they're referential. I don't know what they prefer. Then they don't understand it.	Insufficient knowledge	EHS2
This is funny because when you ask them what does the risk assessment say, we don't have access to it. Because that is by the manufacturer. But. Yeah, but you shall have access to it somehow, so you can see why and how they assisted.	Unclear communication Bureaucratic hindrances	EHS2
That was their answer because there was their knowledge. Because no, yeah, not their knowledge, but their lack of knowledge then is right answer to them and that's why in their truth they can't access it.	Insufficient knowledge Bureaucratic hindrances	EHS2
When they get injured, your production stops and like you want to invest here, you want to see yourself in court and I can inform you the assessed price in court will be.	Insufficient knowledge (Unclear communication)	EHS2
But the reason and the principles behind why they are required to do a so they don't get.	Insufficient knowledge	EHS2
Probably it's good to tell you why…	Risk Communication	EHS2
That you imagine or believe to your knowledge as a project manager that is needed and enough for them. Nearby you are indirectly the filter and also the root cause for miss or lack of information as the highest common denominator	Unclear communication (Insufficient knowledge)	EHS2

	➔ Risk perception and Risk communication	
Like it's hard to make sure someone understood it. To the point where someone did it wrong	Hindsight bias (insufficient knowledge) Leadership Unclear communication	EHS2
Intervention will not happen before you have reached understanding, and understanding will not happen before reach a certain level of experience and examples to exemplify why you need that level of understanding.	Insufficient knowledge	EHS2
… in the long run that they'll get, they'll have an ergonomical challenge because what I saw there, what I could picture is. They had some stupid movements built into the way they were approaching…	Insufficient knowledge	EHS2
They believe they know what happens and because they know what happens, they believe they have it under control.	Insufficient knowledge (Hindsight bias)	EHS2
Problemet är ju ofta kommunikation. Så man har en idé om det här som kan vara en risk. Det här kanske är en risk men det är inte så många som vet om det för de har inte varit på byggarbetsplatsen och jobbat.	Unclear communication Insufficient knowledge	PL
kan det ju vara tänker jag att om man börjar bygga och sen upptäcker man under bygget att man måste projektera om saker alltså vissa delar då behöver ju bas p vara med och titta på projekteringen om det är stora ändringar	Need for iterative process	PL
Jag vet inte om kommunen har samma bild men jag tycker att det är ganska allvarligt risker liksom och det kommer bli svårt och dyrt men vad de gör med den informationen det kan jag inte riktigt styra över.	Insufficient knowledge	PL
Så tror jag att den här förvirringen mellan vilken hiss som skulle vara det beror mest bara på alltså på att de kanske inte är han Magnus som var med från början. Jag har ju pratat med hans kollega Håkan först så jag tror att det kanske antingen så har Håkan missuppfattat mig och meddelade Magnus eller har Magnus och missuppfattar Håkan alltså det har blivit en missuppfattning	unclear Communication	PL
är inte van vid att jobba med hissar så här så jag kan ingenting om hiss så det jag skulle säga så här att det har kommit in så sent i projekten det beror	Insufficient knowledge Time in project	PL
Vi hade gärna vetat allt mycket noggrannare men det är ofta så här i projekt.	Unclear Communication	PL

	Insufficient knowledge	
att det beror på att man kanske inte vet så mycket om området när man börjar arbetet och sen lägger till sen kan det också vara i ett annat projekt jag jobbade i där när det kommer nya det är många olika aktörer som tänker olika det är liksom kanske	Insufficient knowledge	PL
att man har en viss begränsad information om man börjar och sen när man börjar göra research eller man börjar arbetet då ser man ny information som kommer fram	Insufficient knowledge	PL
börja med vårt ärende så såklart bättre planering då kanske kommunen skulle gjort ett ärende hos Vattenfall men om de inte visste att det skulle ta 8 månader då tänker man inte på det så att ja bättre planering bättre kanske att ta lite mera tid i början för att förstå vad vilket arbete som ska göras och sen att man ser till att man har mandat från beställaren	Insufficient knowledge	PL
en planeringsfas och att man går igenom projektet lite noggrannare vad och kanske gör en lite mer för ofta när man får ett projekt då ska man starta så här men att man kanske skulle behöva sitta tillsammans med beställaren också så att man har samma bild av vilka risker som finns här och nästan göra som en liten workshop	Unclear communication	PL
väl många gånger att få beställaren att förstå att det är värt att lägga de pengarna i början	Insufficient knowledge (Unclear communication)	PL
då kan det lätt bli om man att beställa den kanske tycker varför ska ni lägga så här mycket tid i början många kan ju tycka	Unclear communicatiomn → Why?	PL
… kommunikation emellan de olika aktörer skulle också gynnas av att ha helt enkelt oftare möten	Unclear communication	PL
har kompetent personal alltså	Insufficient knowledge	PL
är ju såklart att folk inte orkar läsa när det kommer en viktig information	Unclear communication → Why?	PL
So in combination of a basic understanding of the basic principle in machinery safety. Nobody asked them if they knew enough or they had the right knowledge because they either got confirmed they had the right knowledge indirectly by asking others who were stating that they knew what was right or wrong. And then also it got blurred by the basic understanding.	Insufficident knowledge (Unclear communication) → What does the machinery directive include when used in practice?	EHS1
Nobody asked them if they knew enough, or they had the right knowledge because they either got confirmed they had the right knowledge indirectly by asking	Insufficient knowledge	EHS

others who were stating that they knew what was right or wrong. And then also it got blurred by the basic understanding. No, you don't do this because of common sense, thereby missing very core and basic principle in the machinery directive. You have to construct the equipment to be safe for normal use and foreseeable misuse and foreseeable misuse is a core point that they missed or did not understand if they had read it. Foreseeable misuse is impulsive, passing the fence where there's a opening in the fence going into the machinery area, which for a maintenance engineer and maintenance personnel		
: They asked for help with the CE marking which they were clearly assessing as being a minor formality in the big picture. As they had put together a perfectly safe s working system which works running at the time being when I visit them. So therefore it was considered a formality just to put on the official assessment and confirm that what we did is safe and that means in hindsight the end of the activity seen. We were pulled in too late.	Insufficient knowledge	EHS
They don't know, what they don't know, so their truth	Insufficient knowledge	EHS
So they're only feeding into a new part of the machine, so. All the conveyors and the screening system and all that. Supplying to the X-ray machine, which it is here the core new part of it. All that is normal procedure for them, so I'm pretty sure they did not look into manuals or instructions on that part they just saw. Equipment similar to what we have, we'll do as we normally do. And then, oh, the X-ray machine. Somebody needs to look into that. Where's the manual? That is the way that I see it happened	Insufficient knowledge	EHS
One example could be to sit down and say you guys are experienced. Please put that experience aside and take a clean look. This is the conveyor part of it. You see anything that is similar to what you've seen before and it's something that is unsimilar to. Please find the unsimilar parts. Focus on that. What is new for you? please run through the instructions	Unclear communication (Positiv)	EHS
Share that knowledge with our mother company, so that this will give us the credit and the honor of finding new risks. This will make us in good standing with the other company.	Unclear communication	EHS
define value based on the assessment of the profile	Unclear communication	EHS

	(Insufficient knowledge)	
Then my answer is my assessment is you'll save 50,000 kroner in October, that you would have a better work environment and more safe environment, which makes it attractive for you to attract. New workers. Then I start answering. His question directly on the money value, and then I add on and widen his he's still of understanding with additional information	Unclear communication (positiv)	EHS
… på vilken process som man behöver analysera och se liksom hur är det meningen att man använder den här utrustningen eller maskinen för att kunna förstå det så gott som möjligt	Insufficient knowledge	BUM
…, vilken roll de har och om de har varit med eller inte om man säger så då behöver man ju liksom tillsammans komma fram till att det finns en fara med det här till exempel. Kan det här hända eller inte?	Unclear communication	BUM
Det är ju operatörer de som har mest kännedom om hur man gör det dagliga arbetet, så vi är måna om att vi inte kan göra en riskbedömning, till exempel utifrån bara en instruktion för hur man jobbar, …	Insufficient knowledge	BUM
Men vi har inte fått in på det här, utan det måste man komplettera och då kan man ha ett uppföljande tillfälle	Unclear communication Insufficient knowledge	BUM
om man oftast så har man ju någon form utav möte och i det mötet så kommer man fram till att man inte har all information utan, det måste kompletteras.	Insufficient knowledge Unclear communication	BUM
greenfield alltså om du har en befintlig anläggning som nu utvecklar alternativt om du bygger en helt ny, så har det ju liksom inte driftsätt eller liksom. Då har du inte kört den om man säger så + Man behöver ju börja i design skedet redan alltså.	Insufficient knowledge Inconsistent thinking Insufficient knowledge	BUM
[…]säkerställa att. Designen blev som det skulle bli när du sen kör den på riktigt så ser vi att liksom det verkligheten stämde överens med det designade. För att jag skulle säga att det händer väldigt ofta och så inser man saker efteråt när du har ju byggt en lina eller maskin.	Insufficient knowledge	BUM
Och då finns det ju risk att man gör den där ändringen efteråt och då kommer det liksom inte med i grunden projektet, vilket gör att det inte är säkert att du samlar dokumentationen på ett bra sätt. Vilket gör att du har en risk, men du tror att du inte har en risk.	Insufficient knowledge	BUM
Jag upplever att kunder som har en längre erfarenhet av vad det innebär, både liksom I lidande när det är väl någonting råkar gått fel, såväl som innebörden för en	Insufficient knowledge (not enough experience)	BUM

produktionslina, det vill säga en har du varit med om att någon har skadat sig. Du får stänga ner fabriken, det blir polisutredning. Den kostnaden kommer man varit med om det då är man väldigt mån om att ha sagt hög prioritet på säkerhet, framför allt.		
Säga när man driver i projekt och eller en. Ja. Operations då tror jag inte alla sitter där och har en medvetenhet om. Vad kostar det om man säger så då att inte ha tagit hand om disk?	Insufficient knowledge Unclear communication	BUM
Det är det även många kunder jobbar vi känner vi till vilka de är genom att vi är på så många olika ställen så att vi har oftast en väldigt bra grundbild utav med vilken typ av företag det är och hur vana de är eller vilket förståelse de har för de här frågeställningarna. Så det är liksom någon sorts vår erfarenhet och kollektiva medvetenhet på något sätt som vi använder oss utav.	Insufficient knowledge (need for a third part while at the same time have a good relation)	BUM