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Machines like us?

An Occupational Health Perspective on Machine Learning (Artificial Intelligence)

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Preface

This is a master thesis for the Executive MBA program within the University of Stavanger Business School. The purpose is to develop an industry standard in the form of concrete advice for management and occupational safety and health (OSH) services on how to avoid sick absence related to the introduction and application of machine learning (artificial intelligence).

To broaden the scope further an attempt was made to contact relevant employees and managers from around ten further of the largest companies (private and public) in Norway after the planned data collection was concluded. Most of them were excited to hear about the topic of the thesis and saw challenges in the pace of change and level of digitalization their companies had reached. Despite assuring them of full confidentiality, they all chose to consult their managers for permission to participate and withdrew their wish to participate thereafter. I have added this as a curious note to the preface rather than including it in the main report.

Additionally, in the final weeks of writing this thesis (March 2022), I attended a digital course arranged by NIVA (Nordic Institute for Advanced Training in Occupational Health) called “Transformation of Work in the Digital Era”. Several of the presenters were from the FIOH (Finnish Institute of Occupational Health). When this thesis mentions FIOH, it is an experience transfer from this course where representatives from the Nordic labor inspectorates and occupational health institutes attended and presented as well as participants from some of Europe’s largest companies. In an open discussion, the presenters agreed that a new industry standard would have to come from the industries themselves and that there is a pressing need for this and for increasing awareness about this topic.

It can be challenging to raise awareness about a phenomenon that has little attention in the general population, even though research supports it. Despite the challenges, it can be a highly rewarding and meaningful road – even if it means that the path has to be carved one step at a time. If sickness absence in one person, one team or one company may be prevented – this thesis has fulfilled its purpose.

Summary

Aim Focusing on management theories and occupational health and safety (OSH) principles, the use of machine learning (AI) may give benefits within risk management, economical costs, as well as prevent sickness absence and work-related illness. The purpose of this thesis was to develop an industry standard in the form of concrete advice for management and OSH services on how to avoid sickness absence related to the introduction and application of machine learning (AI).

Method This thesis is a literature-based monography set in the Norwegian work-life context. An explorative, qualitative research design was chosen with a phenomenological approach. Three main theoretical perspectives were explored, namely the psychological, sociological and cognitive perspectives. In addition, a literature review was performed, and white spots on the theoretical map were defined. This set the theoretical framework for the empirical part of the study, consisting of two focus group interviews from two of Norway's largest companies. Both companies were data driven and front runners in their fields and were chosen from a vendor (Kongsberg) and buyer (Equinor) perspective. This data was then triangulated against an in-depth interview from SINTEF, one of Europe's largest research institutes. For external validity, thick description was added.

Limitations may be the sample size in data collection and bias due to the companies chosen. Additionally, there may be researcher's bias as a company doctor and leading advisor of a multi-disciplinary occupational health team for one of the companies interviewed. **Contributions to state-of-the-art** To the researcher's knowledge, this may be the first study of its kind where international OSH advice and research findings from review articles (and a workshop summary) is combined with experience transfer from managers and employees in this phase of machine learning (AI).

Findings show that to prevent machine learning (AI) related sickness absence, the decision makers will need to acquire related OSH competence, perform dynamic virtual task analyses and from the outset integrate OSH measures in early phase developments of machine learning (AI) by utilizing human centered design. The OSH services will need to work more cross-disciplinary again, develop one common language based on Human Factors and perform dynamic evaluations of occupational health risk. The tripartite dialogue with the safety delegates will need to be strengthened with the same competence.

Acknowledgements

I am truly grateful to my mentor for this thesis, professor Dr. Jan Erik Karlsen, for his professional and pedagogic guidance. His previous research and literature, long and diverse experience and knowledge on various fields and especially on the topic of the work environment act and future of work debate was a great support for all the discussions during this study.

This thesis would not have been possible without the interviewees from Equinor, Kongsberg and SINTEF. Their openness, trust and experience transfer was a true gift in a time when technology still is seen largely as only a benefit and raising awareness of digitalization as an occupational health exposure can be challenging. Painfully aware of adding one more task to your schedules, I may only repay you by one day hopefully making this research sufficiently known so that it may aid you.

I am immensely thankful to my contact persons in Equinor- Knut Jørgen Arntzen (Chief Medical Officer, Health and Working Environment) and Kongsberg- Lars Henrik Lund (Global HSE manager, Health Safety and Environment) who helped facilitate the requests to possible interviewees.

And from the bottom of my heart, a huge thanks to my loving husband for immense support, constructive feedback and help with proofreading this thesis. I am also grateful to our 3 wonderful children, extended family, friends that became family and colleagues for bearing with me during this journey. Without you all, this would be truly impossible. For allowing me to still my curiosity and for acknowledging this degree and study as a need of my personal development, I owe you my everything.

Stavanger,

May 26th, 2022

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1 Introduction

In the age of the fourth industrial revolution, where the Internet of Things and machine learning (artificial intelligence) are driving automatization at a formidable pace, (Barland & Koksrud, 2020, p. 12) argue that "intelligent machines are taking over decision making from humans, shifting power and making us superfluous in an increasing amount of tasks".

The European Occupational Safety and Health Administration (OSHA) warns that workers and their representatives may lack information about, and power over strategies adopted and decisions made (OSHA-EU (2021, pp. 1-3)). They observe that AI facilitated real time data collection about workers, algorithm based organizational decisions, and emerging HR management trends as people analytics and gamification are giving rise to increasing concerns over legal, regulatory, and ethical questions as well as occupational safety and health. Mental health is especially of concern due to the possibility of less autonomy, more monitoring and surveillance, competitiveness and social isolation amongst others.

Additionally, in a virtually organized task environment, the opportunity for employees to internalize values, attitudes and expected behavior is less, thereby increasing the need for control, surveillance and follow up. (Kaufmann & Kaufmann, 2015a, pp. 254-255) claim that this may increase adverse behavioral reactions that may show as lower productivity, more mistakes, increased sickness absence and isolation tendencies.

In sum, this could pose a threat to the Norwegian work life model, which is highly based on autonomy and involvement, supported by the Norwegian Working Environment Act. The latter still states its purpose to: «Secure a working environment that provides a basis for a healthy and meaningful working situation, that affords full safety from harmful physical and mental influences and that has a standard of welfare at all times consistent with the level of technological and social development of society» (Chapter 1, section 1-1, The purpose of the Act (Lovdata)).

If the risks associated with machine learning (AI) introduction and utilization are not mitigated in an early phase, it may lead to increased sick absence, work-related illness and work environment issues.

The aim of this thesis is to develop practical advice for managers and occupational safety and health services in an era of fast paced digital transformation, so that employers may still offer employees a safe work environment. Factors that may reduce machine learning (AI) related sickness absence are discussed.

Summary: In an age of fast paced digital transformation, current research shows a pressing need to develop clear OSH advice for employers for implementing and utilizing machine learning (AI) to avoid negative consequences on occupational health and work environment. As we enter the exponential curve of machine learning (AI) development, this paper aims to complement and concretize international OSH recommendations within this field with experience-based knowledge acquired up to now. The goal is to develop a state-of-the-art industry standard to mitigate occupational health risks of machine learning (artificial intelligence), thereby reducing the associated sickness absence.

1.1 Rationale for this thesis

Norway aims to become a world leader in artificial intelligence (UiB, p. 15; Ådnanes, 2020). Whereas the previous phase was marked by a patchy introduction of digitalization and robotization, the current phase is accelerated and expected to accelerate further. In a report by the Technological Council (Barland & Koksrud, 2020), it is argued that although we are in the exponential curve for digitalization, it may take a long time before we see the full effect of a technological shift. In the meantime, human beings will still have to work alongside it, with the continuous changes it brings, adapt to it and compete with it in order to make it more effective.

As we enter the exponential part of the S-curve of machine learning (AI) development (Figure 1), it might be wise to take a step back and evaluate how this has been implemented so far, learn from the experiences and adapt further implementation with that knowledge. This is important because the tempo of this current phase is higher and expected to accelerate. (Moore, 2019, p. 15) argues that «It is not AI technology itself that creates risks for the safety and health of workers, it is the way that it is implemented, and it is up to all of us to ensure a smooth transition to increased integration of AI in workplaces».

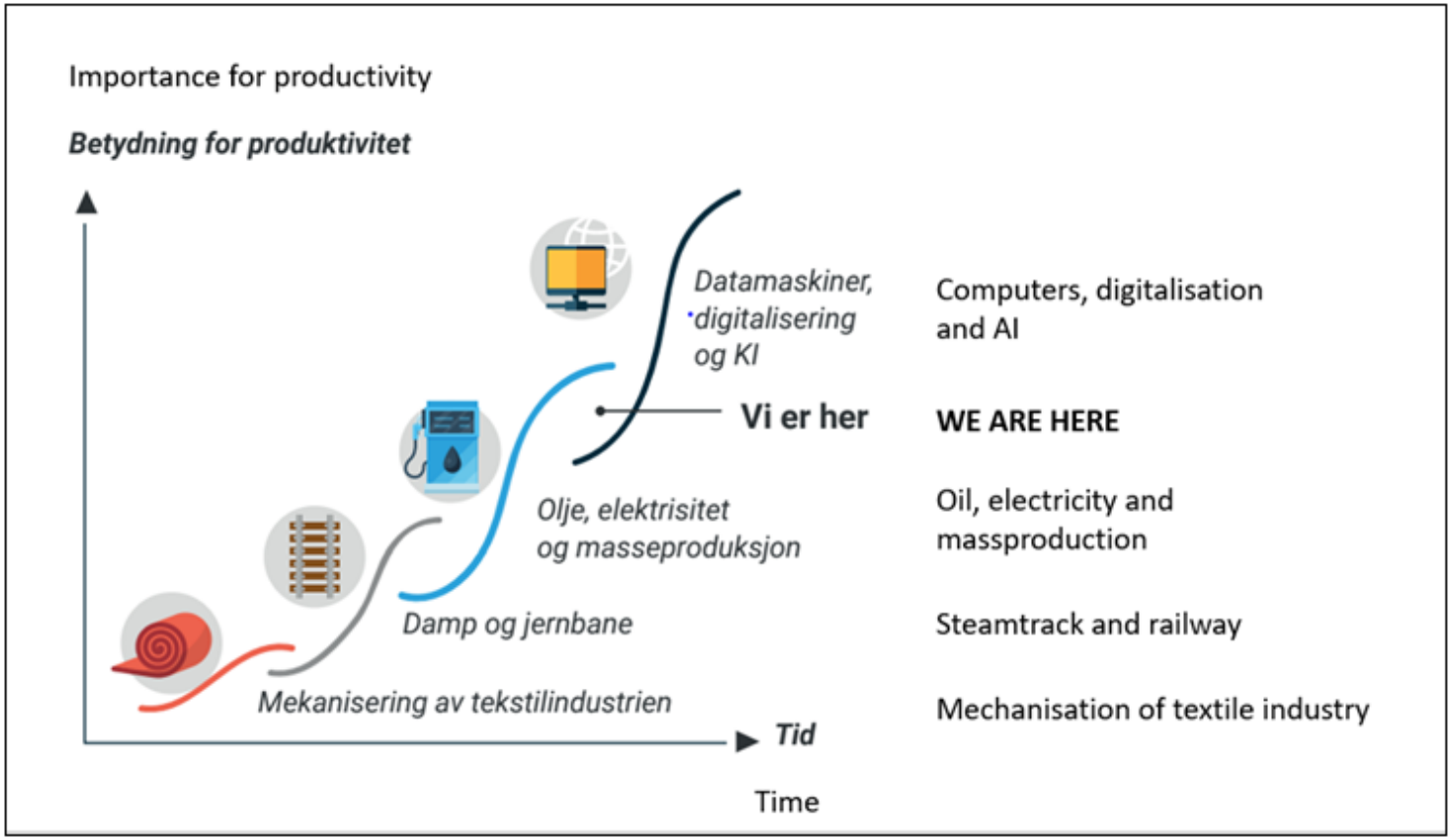

Figure 1 Source: Adapted after diagram from the Norwegian Technological Council's report "What is happening to our jobs?" (2020) (Translation is the researcher's addition)

1.1.1 What is machine learning (AI)?

What then, is artificial intelligence? (Rimol, 2021) defined it as “digital systems that execute tasks that normally require human intelligence. It uses advanced analysis and algorithms, including machine learning, to interpret incidents, support and automatize decision making and to execute actions.”

Artificial intelligence is divided in two main directions: one based on rules, and one based on machine learning. Rule based AI is based on simple rules made by humans. Machine learning, on the other hand, is described as the modern variant of artificial intelligence and is based on rules we are unable to write down. It entails understanding the “silent” knowledge and making computer programs that can learn from examples. (Normann & Øye, 2021) argue that although it can only solve specific, defined problems, it cannot replace general intelligence that is needed to build whole systems for example. According to (SINTEF, 2021) its benefits lie in relieving humans of the more time consuming, repetitive tasks but as it stands, in its current form it can aid in some tasks but not replace human intelligence entirely.

On the other hand, the theory of multiple intelligences describes 9 types of natural intelligences (verbal-linguistic, logical-mathematical, spatial-visual, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalist and existential intelligences)(Gardner, 2011). Machine learning covers possibly 1 or 2 (logical-mathematical and spatial-visual) of these multiple intelligences. Even though it may alleviate humans of boring and repetitive tasks, it is not able to cover all the types of intelligences and might even lead to an increase some repetitive tasks in intelligences it cannot cover. Work life as we know it, is highly reliant on interpersonal intelligence- the capacity to detect and respond appropriately to the moods, motivations and desires of others as well as intrapersonal and linguistic intelligences. As the tasks requiring logical-mathematical and possibly the spacio-visual intelligences are increasingly taken over by machine learning (AI), how will this influence the working environment?

The occupational safety and health (OSH) field has traditionally been more heavily focused on the physical working environment. Although the changes in the working environment act in recent years on the topic of psychosocial working environment have led to an increased focus on this area as well, there has not been the same degree of focus on the effects of digitalization on the psychosocial working environment as yet. The newer focus areas of Human and Organizational Performance (HOP) and Human

Factors (HF) do raise awareness on an organizational and individual level, but the same is not true for digitalization's long-term effects on the working environment and the worker. As the fast paced digital transformation currently rolls over the industry in most companies and businesses, the OSH services and companies themselves are not prepared to assess the risks as work life changes, although OSHA-EU has added digitization as one of their 3 emerging risks areas. (EU-OSHA, 2021). The Nordic labor inspectorates confirm the same picture.

A recent review article conducted by STAMI (Statens Arbeidsmiljø Institutt -the National Institute of Occupational Health in Norway) examined the possible consequences digitalization and newly adopted technologies in work life have on the workers' psychosocial work environment, occupational health and well-being. This paragraph is largely inspired by the latter. They found several studies pointing to that, although the same technological changes could have both negative and positive effects on workers' well-being, the potential for these effects depended on the **context** the technology was implemented in, its specific **function** and **the way it was introduced**. A sense of loss of autonomy could cause adverse occupational health effects, but conversely a strengthened sense of autonomy could give positive effects on health and wellbeing and also help in executing the tasks (Christensen et al., 2020, pp. 4-5).

In this developmental phase of machine learning (AI), and in the context of the Norwegian work life model, this paper aims to develop concrete advice for employers and OSH. The Norwegian work life model is characterized by a high degree of involvement and tripartite dialogue between the employers, employees, their representatives and the safety officers (The working environment act Chapter 6: Safety representatives). Especially interesting is **Chapter 4, section 4-1 General requirements regarding the working environment**

> (2) When planning and arranging the work, emphasis shall be placed on **preventing injuries and diseases**. The organization, arrangement and management of work, working hours, pay systems, including use of performance-related pay, **technology**, etc., **shall be arranged in such a way that the employees are not exposed to adverse physical or mental strain and that due regard is paid to safety considerations**.

Due to a high degree of autonomy and involvement, the Norwegian employees are able to deliver higher workloads and handle more responsibility than compared to their peers

around the world. It is questionable that the same could be true under conditions with lower autonomy. The work environment act **Section 4-2 Requirements regarding arrangement, participation and development has a requirement**

2) The design of each employee's working situation shall pay regard to the following:

a) arrangements shall be made to enable the employee's **professional and personal development** through his or her work,

b) the work shall be organized and arranged with regard for the **individual employee's capacity for work, proficiency, age and other conditions,**

c) emphasis shall be placed on giving employees the **opportunity for self-determination, influence and professional responsibility,**

d) employees shall as far as possible be given the **opportunity for variation and for awareness of the relationships between individual assignments,**

e) **adequate information and training** shall be provided so that employees are able to perform the work when changes occur that affect his or her working situation.

To comply with the working environment act, employers need to manage the occupational health risks of working alongside machine learning (AI) and other technology in such a degree that the abovementioned requirements can be met.

1.1.2 Where are we headed?

As already mentioned, the Occupational Safety and Health Administration in Europe (OSHA-EU) describe that that AI facilitated real time data collection about workers (e.g., websites visited, phone calls made etc.) is already being used to make automated or semi-automated algorithm-based management decisions on organization of work, performance, or productivity for example. People analytics and gamifications are other examples of new, emerging areas from this and HR management.

This challenges mental health especially as «…they may result in workers losing control over their jobs and to increased micromanagement, performance pressure, competitiveness, individualization and social isolation. Workers may feel that their

privacy is being invaded, also a source of anxiety and stress. They may be unable to take breaks when they need to, which may cause accidents and health issues such as musculoskeletal disorders and cardiovascular diseases. Unstable work schedules, such as the short-term schedules established automatically by algorithms, have a variety of negative impacts on workers, including increased work–family conflict and work stress and income uncertainty. The use of workers' data to reward or penalize them could lead to job insecurity and stress. As the key operational components of AI-based forms of managing workers often comprise a 'black box', workers and their representatives may lack information on and power over strategies adopted and decisions made… Algorithmic work assignment offers new challenges in design transparency where fully disclosing the algorithm may not be a viable solution. Companies may be unwilling or unable to share the underlying mechanisms of their assignment algorithms, as they might be patented or proprietary assets. Companies may also desire a degree of user ignorance to prevent the system from being gamed….". On the other hand "These "black boxes" could have been an opportunity for the tripartite cooperation to question working environment factors as tempo regulation, communication or surveillance- all factors that may lead to an increased conflict level in the working environment when there is a lack of information.» (OSHA-EU, 2021, pp. 1-2).

In addition, there are rising concerns over legal, regulatory, and ethical questions regarding these forms of monitoring and managing employees but also for occupational safety and health. (Lee, Kusbit, Metsky, & Dabbish, 2015, pp. 1603-1612).

1.1.3 Technostress

The STAMI study called «Work related psychosocial risk factors for long term sick absence» pointed out role conflict, emotional demands and low management support as the most important psychosocial risk factors for a high level of doctor reported sick absence (Aagestad, Johannessen, Tynes, Gravseth, & Sterud, 2014). Another STAMI study concludes with that role conflicts are the strongest risk factor that influences the development of neck pain (Christensen & Knardahl, 2010, pp. 1-26).

Before we can discuss the effects of digitalization on health and work environment any further, we need to define the terms **«technostress»**. (Christensen et al., 2020, p. 9) explained it as "..various types of new technology, especially digital information- and communication technology. For example, how it invades private life (social media), increases **complexity of work** and **workload** due to a **continuous need to learn new**

tools and tasks as well as working faster. Insecurity related to one's competency and seeing tasks changed or replaced by technological solutions were reported to be associated with low affiliation to the organization». (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008, pp. 417-433) defined "technostress creators" as 1) techno-overload, 2) techno-invasion, 3) techno-complexity 4) techno-insecurity, and 5) techno-uncertainty. They further found "technostress creators" as a totality to be associated with lower organizational commitment (lower job satisfaction), negative affect, and lower technology-enabled performance.

1.1.4 OSH opportunities

If we do manage the risks mentioned, there might be positive OSH opportunities within machine learning (AI) application. EU Science Hub argue that new forms of AI based monitoring of employees «may provide an opportunity to improve OSH surveillance, reduce exposure to various risk factors, including harassment and violence, and provide early warnings of stress, health problems and fatigue. Real-time advice tailored to the individual can influence workers' behavior and improve safety and health. AI-based monitoring could support evidence-based prevention, advanced workplace risk assessment and more efficient, risk-based, targeted OSH inspections. Information could be used by organizations to identify OSH issues, including psychosocial risks, and where OSH interventions are required at organizational level. But ethical decisions and effective strategies and systems are needed for handling the large quantity of sensitive personal data that can be generated». They do, however, caution that data collection should be balanced against privacy rights and safety health of workers. Transparency in data collection as well as empowering workers and their representatives to through the same access to information are highlighted (Warhurst & Hunt, 2019, pp. 1-50)

The Nordic labor inspectorates have collaborated in a report summarizing recommendations called "Work today and in the future: Perspectives on Occupational Safety and Health challenges and opportunities for the Nordic labor inspectorates". In their Specific recommendations they list *adapting to digitization and AI* by reviewing national OSH legislation and reaffirming that the hierarchy of controls for hazard prevention is «considered pivotal in the development of new technological innovation». In *adjusting to the pace of newness* they mention **cooperating with AI designers etc. in early phase developments to address safety and health risks and reviewing the OSH legislation** to «evaluate whether there is adequate protection of worker's psychosocial health from imminent risks of new forms of work such a constant worker

surveillance including rating systems and technostress». Another recommendation is **strengthening the tripartite dialogue** «to find ways and means to reach out to employees and workers in the digital world and new forms of work.» (Mattila-Wiro et al., 2020, pp. 64-68).

1.1.5 Framework for the thesis

This thesis aims to delve into three theoretical main perspectives concerning occupational health and work environment factors: namely the psychological, sociological and cognitive perspectives. This will be followed by a literature search with artificial intelligence/digitalization as the main factor and search words as shown in (Figure 2). Review articles will be selected mainly. Lastly, focus group interviews from two large, data driven companies from a vendor-buyer perspective (Kongsberg-Equinor) will be conducted for experience transfer and triangulated against an in-depth interview from SINTEF. These three main data sources will then be compared, and OSH advice concretized.

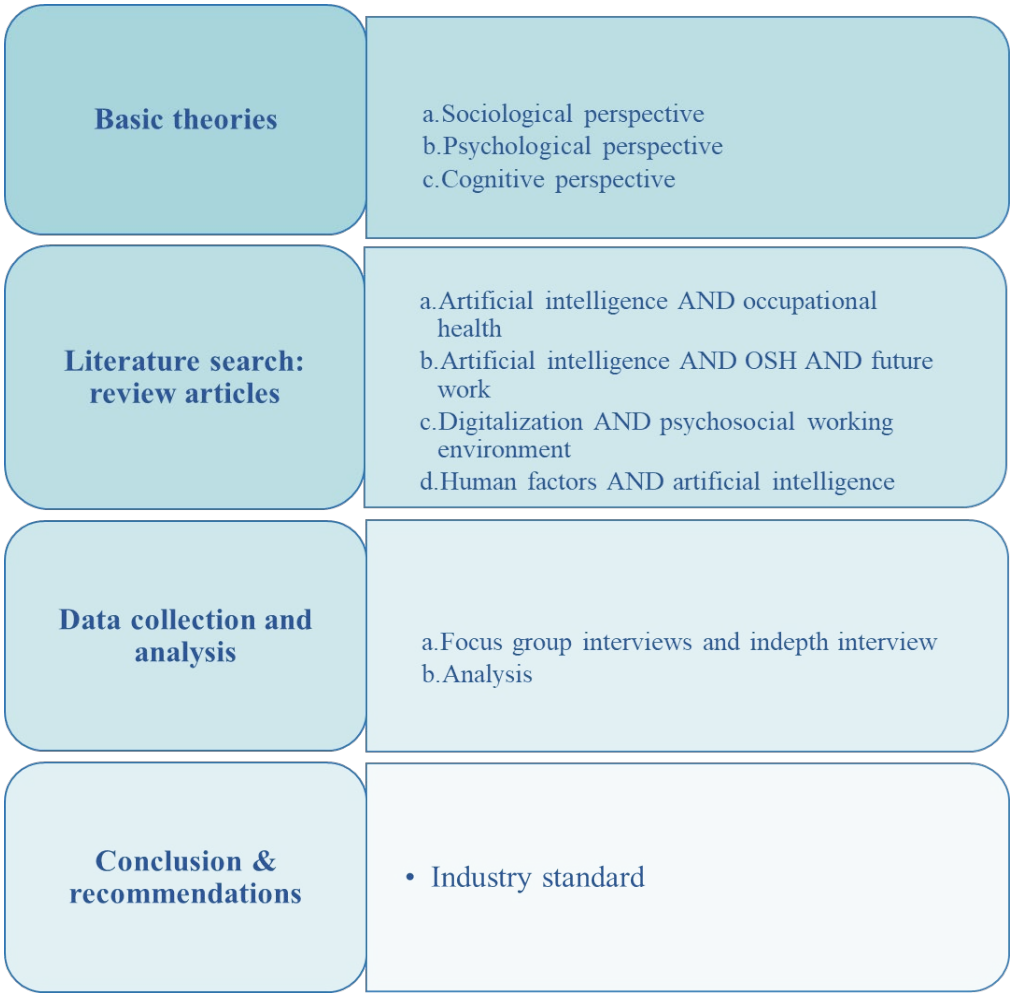

Figure 2 Framework for the thesis

1.2 Purpose of this thesis and main research question

As an occupational health physician with experience from a broad range of companies, the increased rate of change in recent years has had the researcher wonder how technology and specifically machine learning (AI) is affecting worker health. Meanwhile, digitalization has been defined as an emerging risk but in the researcher's experience, the awareness of digitalization as an occupational exposure seems scarce if not non-existent. The latter is observed in not only worker populations, but in management, OSH services and safety delegates as well.

As mentioned, the Norwegian work life is highly based on autonomy and trust between employees and employers. To avoid the risk of losing this trust, the abovementioned recommendations from national and international expert committees should be taken into consideration. To increase understanding OSH risks within the psychosocial work environment and to learn from past experiences in introducing and implementing

machine learning (AI), this paper aims to develop employable recommendations for the employers and OSH services to ensure a safe work environment in a phase of rapid digital transformation so that the risk of related sickness absence may be mitigated.

A review of some foundational principles will be followed by findings from theoretical white spots from review articles (and a workshop summary). This will be compared to an empirical analysis of experience transfer from key position holders in two multi-national, data driven corporations as Equinor (end-user perspective) and Kongsberg (vendor of digital solutions perspective), where the digital strategy is at the core of their business. These will then be triangulated against an in-depth interview from SINTEF, one of Europe's largest research institutes.

Thus, the purpose of this paper is to complement and concretize international OSH recommendations within this field with experience-based knowledge, and thereby develop a state-of-the-art industry standard to mitigate occupational health risks of machine learning (AI).

Research question:

How can we avoid sickness absence caused by the utilization of machine learning (AI) in work life?

2 Theory

The scientific standpoint the researcher takes, has a significance to the meta perspective which again influences the choice of method, data analysis and discussion (Busch, 2021, pp. 47-50)

An ontology is a philosophical belief system about the nature of social reality - what can be known and how. The conscious and unconscious questions, assumptions, and beliefs that the researcher brings to the research endeavor serve as the initial basis for an ontological position. From an ontological perspective, qualitative research concepts are constructed through a semantic process, one in which the researcher specifies the meaning of a concept by identifying the attributes that constitute it.

Epistemology is the theory of knowledge and deals with how knowledge is gathered and from which sources. That is, your view of the world and of knowledge strongly influences your interpretation of data and therefore your philosophical standpoint should be made clear from the beginning. On the epistemological side, cases that have extreme values are weighted more in qualitative studies as opposed to quantitative (Goertz & Mahoney, 2012, pp. 205-216).

Working as an occupational health physician, this researcher found it curious that during an age of digitalization and machine learning (AI) escalation, there was little focus on it as an occupational exposure and a possible health risks. One imagined that the benefits of machine learning (AI) would only be truly harnessed when the attached risks were mitigated, and to do so, increasing awareness was seen as crucial. Even though the OSHA-EU had highlighted digitization as an emerging risk some years ago, there seemed to be little mention of it in media and inside the various companies. When pace increased, which it had already, the occupational health and work environment effects could be detrimental if awareness was not increased. This led to an interest in studying what research showed in terms of findings and areas of risks, triangulating this with main theories within occupational health and work environment and develop state-of-the-art recommendations for employers and OSH services that included experience transfer from employees and managers.

The researcher's ontological perspective, of machine learning (AI)'s effects on worker health and work environment being created through the relationship between the experience of machine learning (AI) and the worker, manager, developer of machine learning supports an epistemological stance of learning to use machine learning (AI) through subjective, interpretative sense-making and meaning. This view therefore has an impact on both upon the way the researcher decides to obtain data and the way in which data will be analyzed in terms of both how machine learning (AI) is introduced and utilized and how new knowledge from the research is brought about. In the research, perceptions of working with machine learning (AI) amongst a group of employees and managers, the researcher's positionality could not be articulated at the risk of bias and the methodology needed to be one where interviewees could express their views without being influenced by comments from the researcher. Also, all data collected needed to be included, uninfluenced by the researcher, and true to what the interviewees said. The method of analysis had to be one where their statements could be interpreted to ascertain the range of answers in a valid and reliable way. Ethical dimensions also had to be considered such as prior negative experiences with either work related illness or adverse work environment effects due to machine learning (AI).

The reading for the literature review and theoretical main perspectives led to a choice of phenomenological methodology for the research. Phenomenology is a qualitative approach. Since the philosophical grounding for the research was that the possible health and work environment effects from introduction and use of machine learning (AI) are based on an individual's experience and their relationship with a phenomenon, a qualitative methodology was needed in order to explore the way in which participants perceive machine learning (AI). The literature review pointed to a lack of awareness and knowledge about the occupational effects of machine learning (AI) in both managers, employees, OSH services and safety delegates. Thus, the phenomenological approach (human experience) allowed for a research based on experiences from a group as opposed to individuals to avoid identification as (Malterud, 2001, pp. 397-400) describes it. Phenomenographic methodology gave the means to determine different understandings of the phenomenon of machine learning (AI) as experienced by the interviewees. This was triangulated against an in-depth interview.

(Brynjolfsson & Mitchell, 2017) argued that we remain very far from artificial general intelligence and the machines cannot do the full range of tasks that humans can do, but

they will in some cases augment human capabilities and facilitate new services, products and processes. Meanwhile, (Brynjolfsson, Mitchell, & Rock, 2018, pp. 43-47) reported that "most occupations in most industries have at least some tasks that could be replaced by AI, but there is at present no occupation in which all the tasks could be replaced. Such research means that the already existing trend that humans and digitalized machines/robots work alongside each other and depend on each other will intensify, calling into question how tasks, jobs, work, and technology should be designed as a whole". They recommended that research focuses on the urgent matter of "how tasks might best be shared between humans and machines, and what might be the consequences of different choices in this respect".

Meanwhile, (Cascio & Montealegre, 2016, p. 356) claimed that "..if technology is to enable people at work, it should foster self-motivation and well-being, key elements of self-determination theory; enhance productivity; and promote job satisfaction, organizational commitment, and citizenship behaviors among workers. Feelings of oppression occur when technology leads to a lack of autonomy, competence, and relatedness. In turn, these lead to stress, demotivation, and counterproductive work behaviors". They concluded that to maximize the positive consequences for individuals and organizations and minimize the negative effects, its critical not only to consider the technology but "how to create and use psychological theory and research to deepen our understanding about how to manage the impact and implementation of emerging developments."

In support of the abovementioned factors, (Manganelli, Thibault-Landry, Forest, & Carpentier, 2018, p. 236) encouraged managers to promote autonomous regulation first by assessing their employees' current motivation and by structuring three elements of the work environment (job design, interpersonal relationships/leadership, and compensation) in such a way as to facilitate psychological need satisfaction. Further, they listed three important levels through which organizations can encourage the satisfaction of employees' needs for **autonomy, competence, and relatedness**. They argued that autonomy can be encouraged by actively providing employees with choice, opportunities to participate in decision making, as well as minimizing surveillance. Competence and satisfaction can be encouraged by providing training, challenging work, performance feedback, and coaching. Furthermore, they claimed that it is equally important to encourage a sense of relatedness by having regular positive interactions

with employees, demonstrating genuine concern for employees' experience as well as encouraging cooperation.

How is this influenced by machine learning (AI), and what counter mechanisms do we need to have in place to manage safely if or when any of these basic principles are changed by machine learning (AI)?

To explain how machine learning (AI) may give rise to adverse health effects, and ultimately sickness absence, this paper will focus on three main perspectives within the psychosocial working environment: namely the psychological, sociological, and cognitive.

2.1 Main theoretical perspectives

The social construct of work in the Norwegian Working Environment act is connected to the working environment itself, where the relation between the employee and the job content is expressed, measured by the organizational and technological guidance, such as what type of freedom to execute the tasks or level of involvement work gives. Added to this are the relations between the employee and other relevant individuals as colleagues, superiors, subordinates or customers for example. (Karlsen, 2018, pp. 120-149).

The Norwegian Working Environment Act states in

Chapter 4, section 4-1 General requirements regarding the working environment
(2) When planning and arranging the work, emphasis shall be placed on **preventing injuries and diseases**. The organization, arrangement and management of work, working hours, pay systems, including use of performance-related pay, **technology**, etc., **shall be arranged in such a way that the employees are not exposed to adverse physical or mental strain and that due regard is paid to safety considerations**.

Further,

The working environment act Section 4-2 Requirements regarding arrangement, participation and development:

2) The design of each employee's working situation shall pay regard to the following:

a) arrangements shall be made to enable the employee's **professional and personal development** through his or her work,

b) the work shall be organized and arranged with regard for the **individual employee's capacity for work, proficiency, age and other conditions,**

c) emphasis shall be placed on giving employees the **opportunity for self- determination, influence and professional responsibility,**

d) employees shall as far as possible be given the **opportunity for variation and for awareness of the relationships between individual assignments,**

e) **adequate information and training** shall be provided so that employees are able to perform the work when changes occur that affect his or her working situation.

Psychosocial working environment is a collective reference pertaining interpersonal interactions at work, individuals' work and how it influences the employee, organizational relations and organizational culture.

Healthy psychosocial work environments are defined by a balance between demands and expectations to a person and the learning opportunities offered, opportunity for independence and autonomy in the tasks and good social interactions in the workplace.

In other words, **psychosocial working environment** relates to the individuals' reactions to and attitudes towards the work. The psychological conditions are thought to show how work and workplace may cause a mental health overload in the employees with reactions such as nervosity, anxiety, restlessness or depression. The **social working environment** consists of positive social relations (feedback, social support, leader support etc.) and negative social relations (conflicts, violence, bullying, harassment). The social conditions connected to the working environment lead to the relations between employees, to their managers or customers. Lastly, the **organizational working environment** entails work time and planning conditions, regulations, procedures and flexibility (Karlsen, 2018, pp. 120-149).

2.1.1 Psychological perspective

The self-determination theory (SDT) maintains that an understanding of human motivation requires a consideration of innate psychological needs for competence, autonomy, and relatedness (Deci & Ryan, 2000, p. 57).

According to SDT, the satisfaction of three psychological needs is essential to facilitate optimal workplace functioning: The **need for autonomy** suggests that individuals must have a say in the way their work is carried out and be able to act in accordance with their values. The **need for competence** specifies that individuals must perceive that the work they do is important and leads to significant results, and the **need for relatedness** is expressed as the desire to have meaningful relationships with others. Employees working in environments that facilitate need satisfaction experience more positive work outcomes (Gagné & Deci, 2005)

At the heart of the job demands-resources model (JD-R model), (Arnold B Bakker, Demerouti, De Boer, & Schaufeli, 2003, pp. 341-356), lies the assumption that whereas every occupation may have its own specific risk factors associated with job stress or burnout, these factors can be classified in two general categories (i.e., job demands and job resources). Job demands refer to those physical, social, or organizational aspects of the job that require sustained physical or mental effort and are therefore associated with certain physiological and psychological costs. Job resources refer to those physical, psychological, social, or organizational aspects of the job that (a) are functional in achieving work goals, (b) reduce job demands and the associated physiological and psychological costs, or (c) stimulate personal growth and development. According to the Bakker model, job resources are aspects of jobs that help achieve work goals, cope with job demands or stimulate growth and learning. Job resources are divided into 1) skill variety and use 2) job feedback and related 3) social and relational and 4) job demands. A second assumption in the JD-R model is that job stress or burnout develops—irrespective of the type of job or occupation—when certain job demands are high and when certain job resources are limited (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001, p. 502).

2.1.2 Sociological perspective

The sociological perspective entails the employee relations, including their relations to what may represent the machine learning (AI).

Herzberg's two factor theory is used as guidance for developing measures that may increase job motivation. The theory differentiates between motivational factors and hygiene factors. Motivational factors relate to the work itself and consist of achievements, recognition, responsibility, advancement and other inner aspects in the jobs. Hygiene factors are the company's politics and procedures, working environment, salary, job security, management and interpersonal relations. The theory stipulates that job satisfaction is created by the job content and reflects the employees need for self-realization. It further states that it is not absence of these motivational factors that cause failure to thrive but instead the jobs context does. Conversely, a high score in hygiene factors results in a good working environment but does not explain job satisfaction. (Herzberg, Mauser, & Snyderman, 1959, pp. 113-120)

Maslow's hierarchy of needs lists five levels, from low to high: 1. Physiological needs, 2. Safety needs, 3. Social needs, 4. Esteem and 5. Self-actualization. The two last ones are growth needs, whereas the others are deficiency needs. Maslow argues that social needs, the highest of the deficiency needs, is actualized after the other two deficiency needs are met. They argue that in an organizational context, it is therefore important to focus on good collaborative relationships at work. (Maslow & Lewis, 1987)

The self-categorizing theory emphasizes the employees' need for identity. In social interaction processes, the differences within a group are toned down and differences between groups are given greater importance. The employee adapts to demands according to what one must do to gain or maintain an identity as within or outside a specific group (Haslam, Jetten, O'Brien, & Jacobs, 2004).

This again is based on engaged commitment which has 3 dimensions: 1) a strong wish to remain a member of an organization 2) a strong faith and accept of the values and goals a company has 3) a will to do a considerable effort for the organization (Mowday, Steers, & Porter, 1979, p. 226). To be able to achieve any of these, social support is crucial. Social support at work consists of a) instrumental support (help) b) information c) feedback and d) emotional support. (LaRocco, House, & French Jr, 1980, p. 204)

Many studies have investigated how social support may play an attenuating moderator role utilizing the JD-R model (Arnold B. Bakker & Demerouti, 2017, p. 282) which provides the conceptual basis for the **buffering hypothesis**. This in turn states that social support is expected to attenuate the negative effects of job demands. The findings have a significant variation, where for example (Beattie & Griffin, 2014, p. 138) and

(Brough, Drummond, & Biggs, 2018, p. 188) report findings that support the role of social support as a buffer against demands in shaping employee outcomes. On the other hand, for example, (Lin, Wong, & Ho, 2014, p. 622) and (Brown, Pitt-Catsouphes, McNamara, & Besen, 2014, p. 3128) find less or no support for findings like this.

2.1.3 Cognitive perspective

Learning in an organizational context is defined as "the acquisition and development of knowledge and skills that are relatively permanent and that are founded on experience". (Kaufmann & Kaufmann, 2015b, p. 247).

Cognitive Load Theory (CLT) is an instructional theory developed to coordinate instructional design and learning procedures with human cognitive architecture. In the most general form, this cognitive architecture consists of two main components: (1) working memory as our main processor of information with a very limited capacity and duration when dealing with novel, unorganized information, and (2) effectively unlimited long-term memory storing cognitive schemas (knowledge structures we use to categorize information for intended use) that vary in their degree of complexity and automation. These two components of human cognitive architecture are closely interrelated with each other. (Sweller, Ayres, & Kalyuga, 2011)

(Plass & Kalyuga, 2019, pp. 354-355) summarized recent advances in CLT and discussed four ways in which emotion can be related to cognitive load: "Emotion can be a source of extraneous cognitive load, emotion can affect virtually all forms of memory, emotion can be a source of intrinsic cognitive load, and emotion can have an effect on learners' motivation….A critical category of goals that needs to be included in this process are those related to inducing an emotional state conducive to learning and to motivating and engaging learners with a learning task. The emotions experienced by the learners during processing can have such a motivating function, broaden available cognitive resources, or allow for reduction of intrinsic load, or using emotion as a retrieval code. Emotion may of course, also narrow cognitive resources or increase extraneous processing requirements".

On the other hand, (Kalyuga & Liu, 2015, p. 3) argue that "high levels of cognitive load in high-tech learning environments could be also generated by the need for learners to distribute their attention between several related sources and modes of information presentation that should be processed concurrently in working memory, and that such environments may easily create **split-attention situations**". They suggest that

"physically integrating the related sources of information (or synchronizing them in time) could reduce the corresponding extraneous load".

2.2 Evaluation of the theoretical contributions

STAMI (the Norwegian Occupational Health Institute) conducted a study called "The influence of digitalization and new technologies on psychosocial work environment and employee health: a literature review" (Christensen et al., 2020). Similarly, it is only in recent years the Occupational Safety and Health Agency Europe has declared this field as an Emerging risk. The international and national OSH advice list possible risks as technostress, telepress, privacy and surveillance risks, physical risks of working alongside robots and psychosocial risks within both competing and working alongside machine learning. Yet there seems to be no industry standard (national or international) concretizing these risks and their mitigation. As a review article by (Pishgar, Issa, Sietsema, Pratap, & Darabi, 2021, p. 26) points out, there were no finds on educational papers or training in AI in OSH either. The OSH services themselves seem to have very little focus on it, how will the companies themselves then be able to set a standard?

One recommendation is a greater ability to identify problems and more skills within problem solving in OSH that are cross disciplinary and that can predict new risks in OSH (Felknor et al., 2020, pp. 6-7). The OSH services have over the years, both nationally and internationally, become increasingly divided in the respective fields, such as ergonomics, psychosocial, and occupational hygiene and the occupational physicians' cross disciplinary role has become more distant from the companies under guidance. To follow Felknor et al's advice, the OSH services will have to work more cross disciplinary again as a start.

Having digital strategies at the core of the business has its own implications for employees and managers within occupational health. The Nordic labor inspectorates are now trying to raise awareness around this but admit that the consequences are already in effect. They see companywide digitalization measures that have not been adequately risk assessed in a holistic view with employee and manager workload in mind. The various departments implement different projects across the company, and the employees and managers bear the simultaneous demands from these. In addition, they see increasing split attention situations as a multitude of digital tools and communication methods continuously impact the individuals simultaneously.

(Badri, Boudreau-Trudel, & Saâdeddine Soussi, 2018, p. 49) conclude that there is a need for research on the consequences for organization and connected psychosocial risks. They also suggest that "...future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools." This is emphasized by (Christensen et al., 2020, p. 29) as well who recommend that «a main priority of future research should be to identify and disentangle the various components of the effects of new work technology on work environment and well-being. In other words, there is a need to clarify why, when, and how technologies influence work and employees." Currently, there are no known tools for such virtual task analysis, but the Nordic labor inspectorates are recommending **check lists** to start disentangling the effects of new work technology as mentioned above.

Meanwhile, (Schwarzmüller, Brosi, Duman, & Welpe, 2018, pp. 114-134) studied how the digital transformation is affecting organizations, focusing on key themes of change in work design and leadership. They claim there is an increased importance of relationship-oriented leadership in the current stage of the digital transformations during which employees are subject to higher job demands, higher autonomy, competency requirements, more challenging work-life dynamics, and where managers provide more influence but demand strong results. They argue that it is crucial that leaders lead with a relationship orientation to support employees under these conditions and do so in a coaching and enabling manner.

Due to increasing work in virtual teams and spread across locations, they also argue to leaders should invest in personal relationships and increase networking as well as lead teambuilding as the flexible teams themselves will find it challenging to do so. The latter is thought to become more challenging due to agile organization and flexible work. Their expert survey concludes with four key themes of change in work design and leadership: **1) work-life and health** (i. e. changed work-life setup, higher importance of health management, increased job demands for employees and leaders), 2**) the use of information and communication technology** (i. e. increased technologization of work and leadership, changed communication and collaboration), **3) performance and talent management** (i. e. increased competency requirements for employees and leaders, changes in performance measurement and management) and **4) organizational hierarchies** (i. e. increased employee influence, changed leader influence behavior).

Despite its advantages, certain specificities of virtual teams' challenge the traditional way in which teams are managed and led. For instance, virtual teams are characterized by geographical and/or organizational distance. This implies that leaders cannot physically observe team members' behavior nor rely on verbal cues, facial expressions, and other non-verbal communication in order to understand the team's thoughts, feelings, moods and actions. This is considered one of the biggest barriers to developing and managing interpersonal relationships (Jawadi, Daassi, Favier, & Kalika, 2013, p. 200). Geographical dispersion often implies cultural diversity between team members, which may affect leaders' ability to build and maintain team spirit and trust (Gupta & Pathak, 2018, p. 781). According to (Sullivan, Lungeanu, Dechurch, & Contractor, 2015, p. 1), space may suppress leadership capacity, even in situations of shared leadership. Moreover, virtual teams are subject to time differences. In order to overcome these challenges, virtual team leaders need to adopt specific behaviors and practices.

In sum, digitalization and therein machine learning (AI) challenges work as we know it and creates work environment risks that need to be addressed. The white spots on the theoretical map pointed out in this paper have implications for both employers, employees, their safety delegates and OSH.

Moving forward

(Parker & Grote, 2019, p. 1) propose a central role for work design in understanding the effects of digital technologies and suggest four intervention strategies: "**First, work design choices need to be proactively considered during technology implementation**, consistent with the sociotechnical systems principle of joint optimization. **Second, human-centered design principles should be explicitly considered in the design and procurement of new technologies**. **Third, organizationally oriented intervention strategies need to be supported by macro-level policies. Fourth, there is a need to go beyond a focus on upskilling employees to help them adapt to technology change**, to also focus on training employees, as well as other stakeholders, in work design and related topics".

They argue that individual factors, combined with technology, work design and higher-level factors need to be combined with intervention strategies as proactive design of work roles when implementing technology, considering human-centered principles in

the development and design and procurement of technology. They also recommend policy-level changes to support better work design and human centered approaches to give positive outcomes as well-being (job satisfaction, engagement, commitment), mental/physical health, attraction & retention, learning & skill maintenance, technology attitudes & behaviors (trust etc.) and job performance/innovation.

This paper aims to evaluate how the technologies have influenced work, managers and employees so far, shed some light over possible improvement areas within work conditions, and devise state of the art OSH recommendations that may become the basis of a new industry standard within this field.

2.3 White spots on the theoretical map

The Norwegian work environment act aims to: «Secure a working environment that provides a basis for a healthy and meaningful working situation, that affords full safety from harmful physical and mental influences and that has a standard of welfare at all times consistent with the level of technological and social development of society». The keyword for this thesis is (in bold) "consistent with the level of **technological** and social development of society".

The white spots on the theoretical map show:

- a need to clarify **why, when, and how technologies influence work and employees.**
- **OSH employees, employers and employers should increase their understanding** of the employee's health, safety and wellbeing applications of AI.
- A **greater ability to identify problems and more skills within problem solving in OSH that are cross disciplinary** and that can predict new risks in OSH.
- Future OSH integration initiatives must **from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools**.
- Need for research on the **consequences for organization and connected psychosocial risks.**

Table 1 White spots on the theoretical map

Search words	Review article/summary	White spots on the theoretical map
Artificial intelligence AND occupational health	REDECA: A Novel Framework to Review Artificial Intelligence and Its Applications in Occupational Safety and Health **(Pishgar et al., 2021)**	This study points out that there were no finds on educational papers or training in artificial intelligence in artificial intelligence in Occupational Safety and Health (OSH). One of their recommendations is that OSH employees, employers and employees should increase their understanding of the employees' health, safety and well-being applications of AI. **Focus group and semi structured interview questions 1-5**
Artificial intelligence AND OSH AND future work	Occupational health and safety in the industry 4.0 era: A cause for major concern? (Badri et al., 2018)	Need for research on the consequences for organization and connected psychosocial risks. Suggests that future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools. **Focus group and in-depth interview questions 1-5**
Digitalization AND psychosocial work	The influence of digitalization and new technologies on psychosocial work environment and employee health: a literature review **(Christensen et al., 2020)**	Recommends that «a main priority of future research should be to identify and disentangle the various components of the effects of new work technology on work environment and well-being. In other words, there is a need to clarify why, when, and how technologies influence work and employees. » Examples from the studies: autonomy and job control, which can be protective when introducing new technology. **Focus group and in-depth interview question 6**
Human factors AND artificial intelligence	How Will the Future of Work Shape the OSH Professional of the Future? A Workshop Summary **(Felknor et al., 2020)**	Several recommendations, one of them is a greater ability to identify problems and more skills within problem solving in OSH that are cross disciplinary and that can predict new risks in OSH. **Focus group and in-depth interview question 6**

To apply the knowledge from the white theoretical fields, it is necessary to assess the current level of machine learning (AI) implementation and use, and then adapt the advice to employers, employees and OSH personnel based on both theoretical and empirical knowledge.

2.4 Main research question

In the past, having a variety of technological and digital initiatives have been regarded as benefits reserved for a select few and larger companies and the rest of society have seen a patchy distribution and implementation. The recent years have seen both company and government digital strategies for implementing machine learning (AI) in both public and private sector. Whereas technology may still be a benefit in business, the employee, employers and OSH professional populations' awareness of machine learning (AI) as a possible work-related ***exposure*** is scarce, if not nearly non-existent. This is supported by the review article by (Pishgar et al., 2021) who concluded that the OSH employees, employers and employees should increase their understanding of the employees' health, safety and wellbeing related to the applications of machine learning (AI).

To do so, (Badri et al., 2018, p. 49) point to the need for research on the consequences for organizations and the connected psychosocial risks. This, (Christensen et al., 2020, p. 29) argue, can be done by making it a main prioritization to map the effects new technology has on work environment and well-being. Additionally, (Badri et al., 2018, p. 49) argue that "future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools". Last, but not least, for the OSH professional to be able to guide organizations in this important work, they themselves need to acquire a greater ability to identify problems and more cross disciplinary skills within problem solving in OSH that may enable them to predict new work environment risks (Felknor et al., 2020, pp. 6-7).

The chosen theoretical main perspectives (psychological, sociological and cognitive) pointed to the following main occupational health risk categories, namely autonomy, tempo regulation, role conflicts and personal conflicts, emotional and psychosocial reactions and cognitive regulation. Figure 3 shows how these health risk categories are

incorporated into the interview questions. Table 1 shows how the interview questions relate to the white spots from the theoretical map.

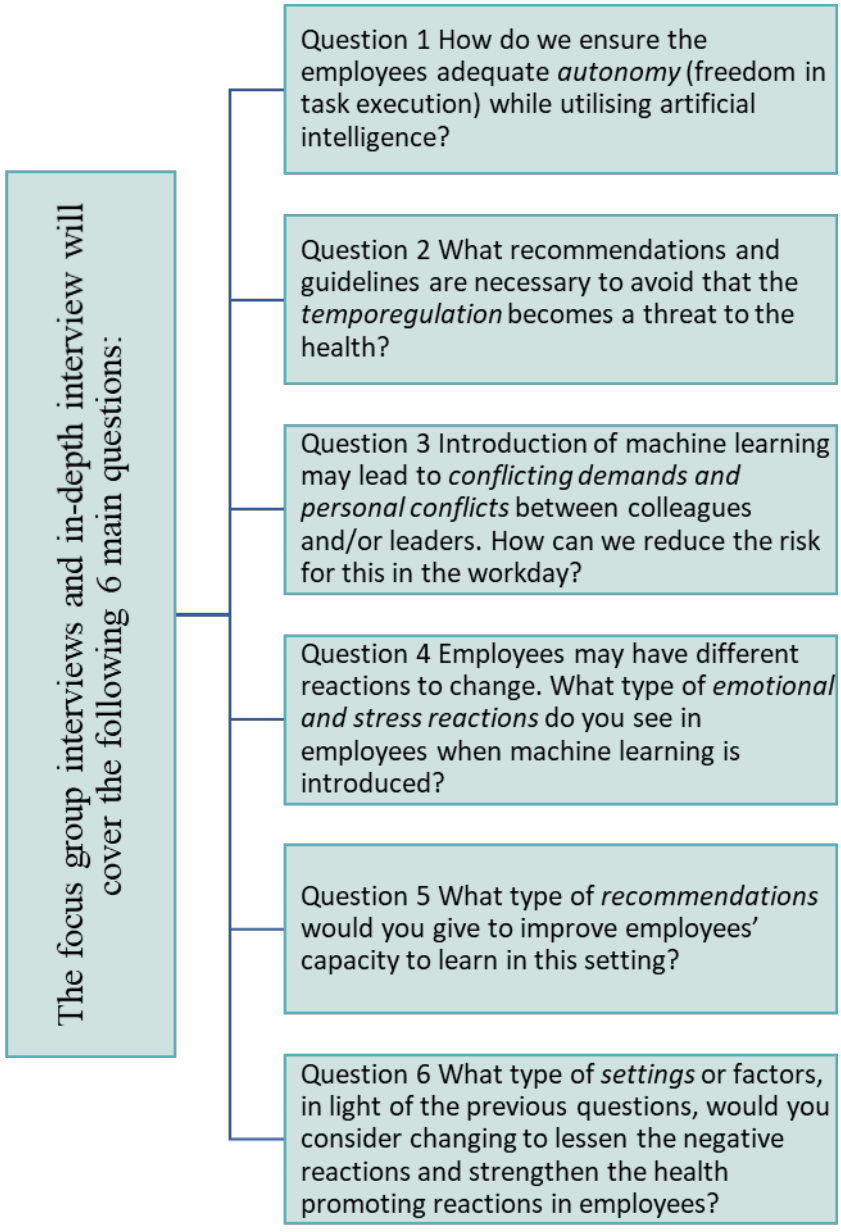

Figure 3 Focus group and in-depth interview questions

Work related sickness absence and illness is one of the consequences should one fail to manage the work environment risks related to machine learning (AI). The prelude to sickness absence, presenteeism, is an additional cost to consider in terms of employee wellbeing, psychosocial work environment issues, and the subsequent employee turnover. Contemplating this, this question arose:

How can one avoid sickness absence caused by utilization of machine learning (AI) in work life? (main research question)

3 Design and Methods

This thesis entails collecting data from Equinor and Kongsberg, two large, data driven companies in Norway and from SINTEF (one of Europe's largest independent research organizations). This data will be triangulated with the white spots from theoretical fields and the three chosen theoretical main perspectives (psychological, sociological and cognitive). The aim is to develop a state-of-the-art industry standard within digitalization and OSH to prevent sickness absence caused by machine learning (AI). With this backdrop, the following research design and method was chosen.

3.1 Research design

Creswell describes five approaches to qualitative studies: narrative research, phenomenological research, grounded theory research, ethnographic research and case study research. "A phenomenological study describes the common meaning for several individuals of their lived experiences of a concept or a phenomenon" (Creswell, 2007, p. 76). Typically, interviews are conducted with a group of individuals who have first-hand knowledge of an event, situation or experience.

An explorative, qualitative research design was chosen with a phenomenological approach. To answer the main research question and the 6 underlying questions (Figure 3), two focus group interviews (from Equinor and Kongsberg) were triangulated with one in-depth interview (from SINTEF). This was an attempt to accommodate several viewpoints and broaden the experience data collection. For external validity, thick description was added.

The focus group interview questions covered the following six main areas: 1) Autonomy 2) Tempo regulation 3) Conflicting demands (role conflicts) and personal conflicts 4) Emotional and psychosocial reactions 5) Cognitive regulation/learning capacity 6) Settings for improvement.

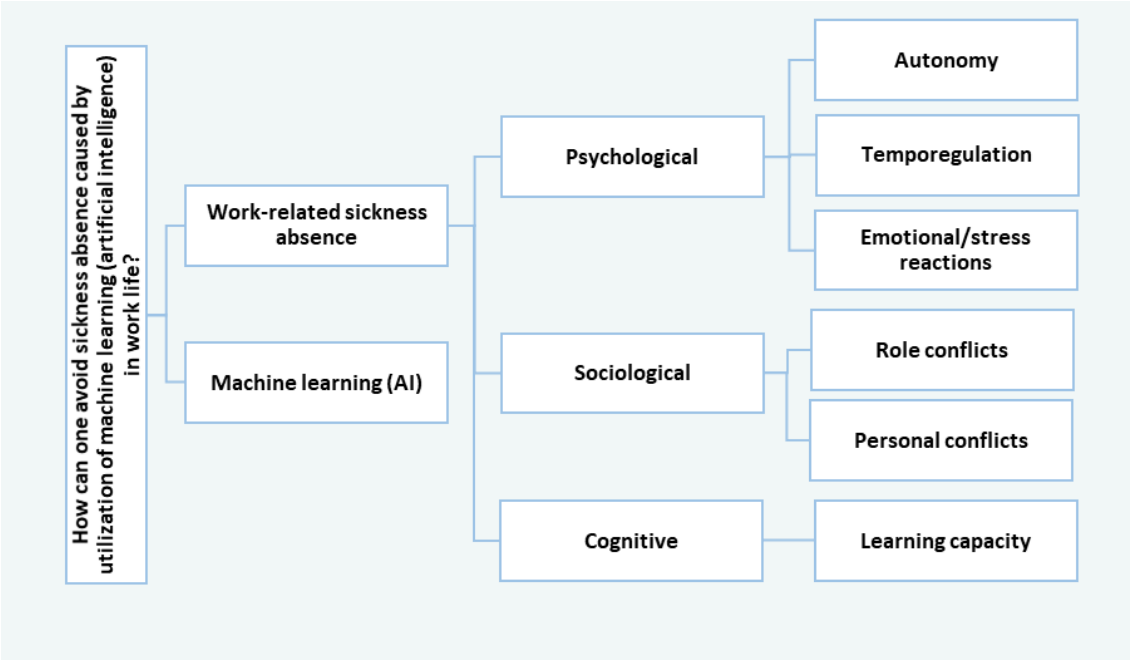

Figure 4 Research question, theoretical main perspectives and a priori themes for the focus group and in-depth interview questions.

The study combined uncharted territory from review articles (and a workshop summary) with focus group interviews within the automation and machine learning field from two front running corporations and an in-depth interview from one of Europe's largest research institutes. The interviewees were a selection of members in strategic positions from different departments within their respective companies and fields, representing both the management and employee experience. Out of consideration for their anonymity, details about their positions or experience were chosen not to be shared in this report.

This was done exploring the main question in a context of entering the exponential part of machine learning development. The tempo of change in the new phase was expected to be much higher than before and it was therefore important to gather empirical learning from the previous phase. Thus, this study aimed to triangulate the knowledge from experience thus far as we entered this new phase and compare it to the findings from the white theoretical in research.

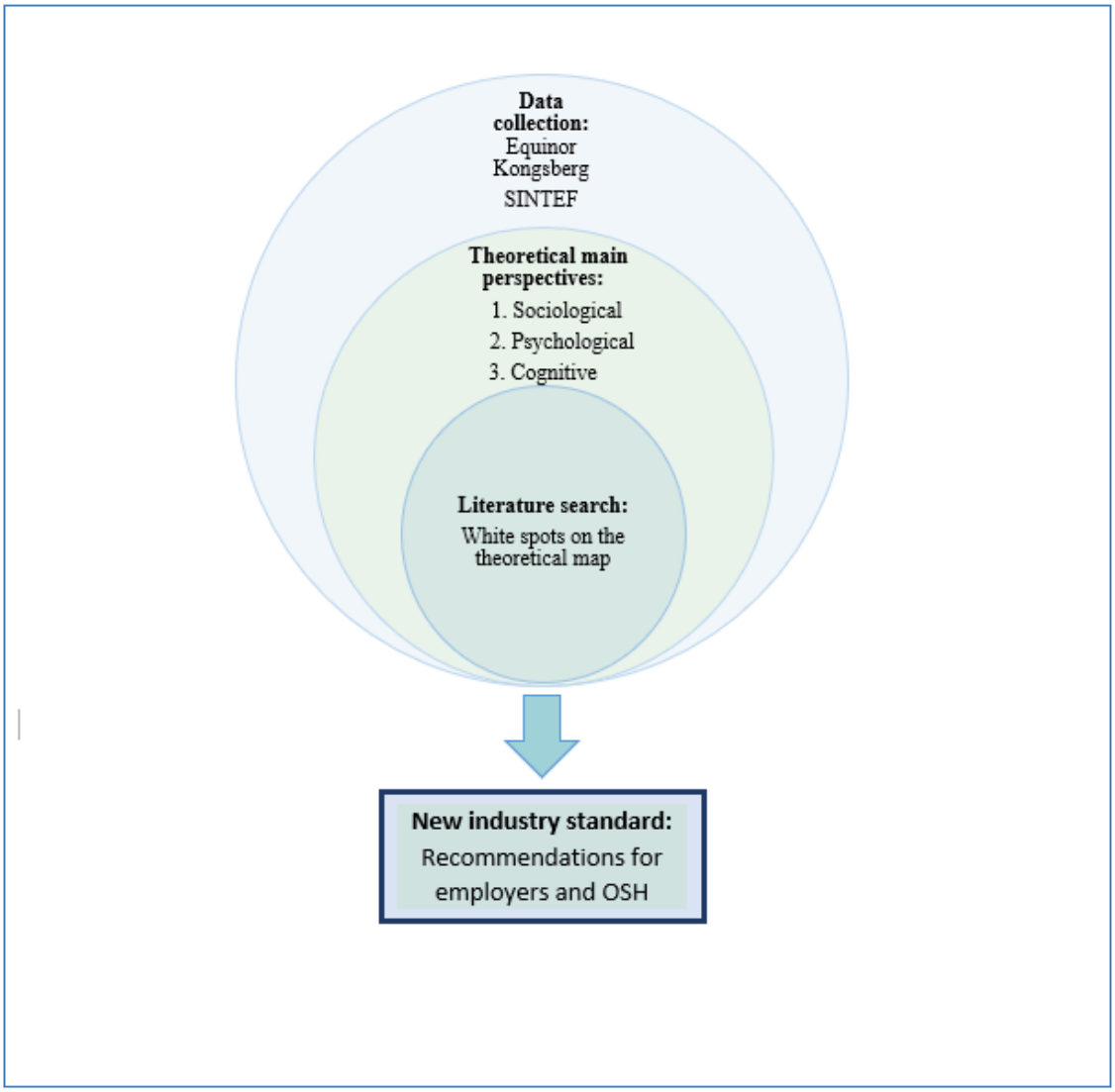

Figure 5 Research design

3.1.1 Theoretical grounding

As mentioned earlier, the Occupational Safety and Health Administration in Europe (OSHA-EU) has defined digitalization as one of the emerging occupational health risks of current time. The Nordic labor inspectorates report a harrowing pace of change in most businesses, marked by companywide implementation of digitalization processes (machine learning (AI)) with no integrated OSH perspective that may help reduce the occupational health risks attached to mental strain and stress. Setting the backdrop to European OSH recommendations and Norwegian work environment act, this thesis is an attempt to see the experience-based data collection in a larger context and validation.

Figure 5 shows the research design and table 1 shows the white spots on the theoretical map from review articles (and a workshop summary). Review articles were chosen because they a) assess the current state of research on a topic b) identify the experts on a particular topic c) identify key questions that need further research and d) show determination of methodologies used in past studies of the same or similar topics (T.G Carpenter library). Meanwhile, the theoretical main perspectives chosen for this study, namely psychological, sociological and cognitive, are some of the grounding principles and prerequisites for psychosocial work environment, and occupational health and mental well-being, both in occupational health theories and the work environment act.

The Norwegian working environment act sets the framework for the employers' duty of care as mentioned in chapter 2 of this thesis. The challenge is to a) define what is the current level of technological development and what have we learned until now b) how to comply with the work environment act in this current context c) knowing that the future holds a much more rapid rate of change even compared to the current fast one, how to continue adapting to the needs of the business, technology and humans in a dynamic manner going forward- all the while still complying with the work environment act.

As both employers, employees as well as OSH services may struggle to see the work environment and occupational health risks, both current and for the future, this thesis is an attempt to develop more concrete advice with involvement from both employee and employer side with empirical data.

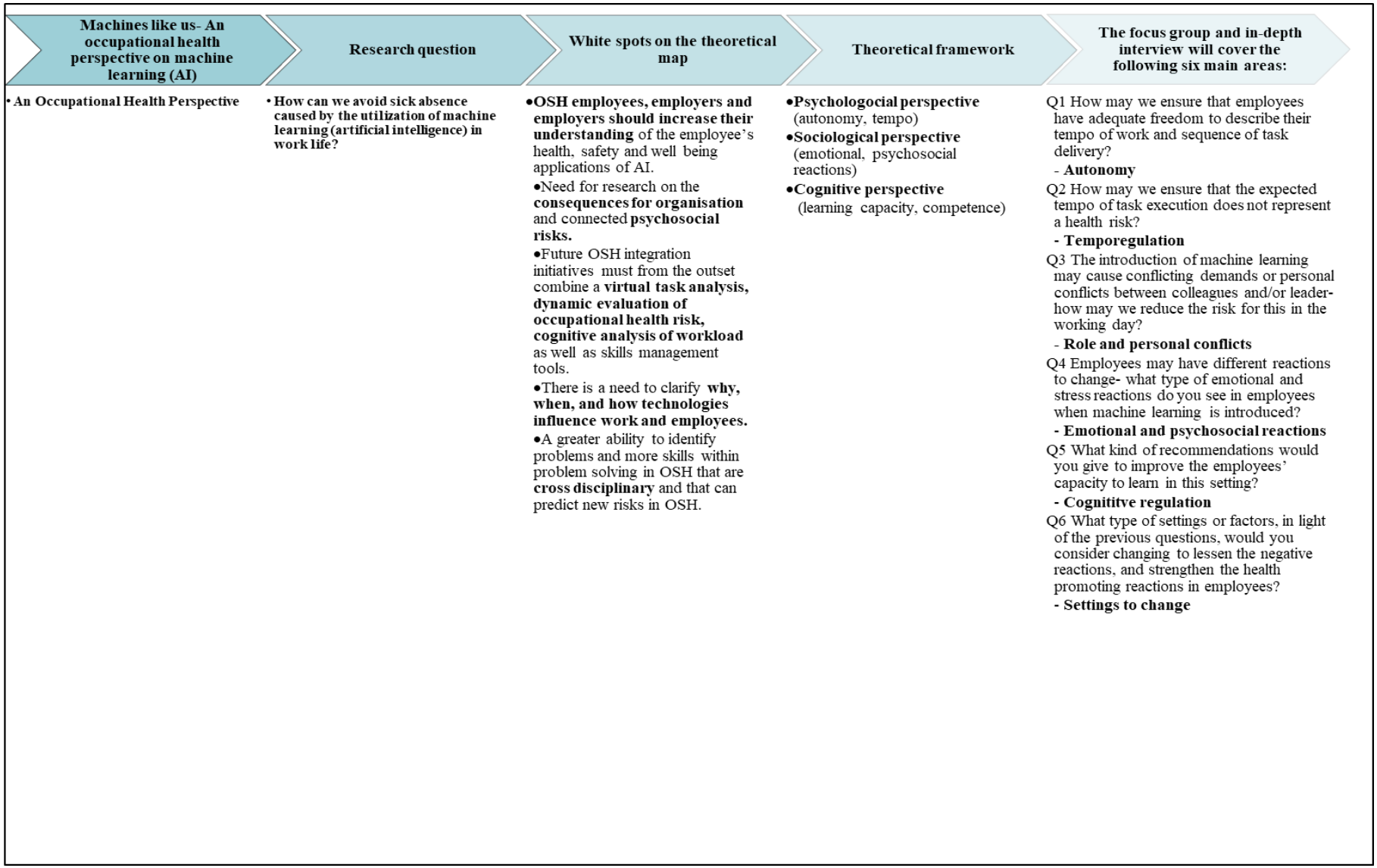

Figure 6 Theoretical grounding

3.1.2 Trustworthiness criteria

(Creswell, 2007, p. 131) points out that in qualitative research the goal is to achieve, as best as possible, an understanding - what he describes as a deep knowledge of some social setting or phenomenon. Striving for understanding requires spending extensive time in the field. He believes that **verification** is critical to evaluating the quality of qualitative research. He further identifies eight procedures for verifying qualitative research findings and recommends that any research study employ at least two of these procedures: 1) prolonged engagement and persistent observation, 2) triangulation, 3) peer review or debriefing, 4) negative case analysis, 5) clarification of researcher bias (reflexivity), 6) member-checking, 7) rich, thick description and 8) external audits. In addition, Creswell believes that (Lincoln & Guba, 1985, pp. 246-251)'s criteria of trustworthiness**, credibility and authenticity** should be employed when evaluating qualitative research. He applies the standard of verification in 5 traditions, where phenomenology is one of these.

(Lincoln & Guba, 1985) posit that trustworthiness of a research study is important to evaluating its worth. Trustworthiness involves establishing:

- Credibility - confidence in the 'truth' of the findings
- Transferability - showing that the findings have applicability in other contexts
- Dependability - showing that the findings are consistent and could be repeated
- Confirmability - a degree of neutrality or the extent to which the findings of a study are shaped by the respondents and not researcher bias, motivation, or interest.

In accordance with the above, according to Creswell's and Lincoln & Guba's recommendations, the following trustworthiness criteria were chosen for this thesis:

- Credibility and confirmability- Triangulation and reflexivity
- Transferability and external validity- Thick description
- Clarification of researcher bias

Credibility and confirmability

Triangulation was chosen as the method for establishing credibility as per Lincoln and Guba's criteria. Triangulation involves using multiple data sources in an investigation to

produce understanding. Some see triangulation as a method for corroborating findings and as a test for validity. This, however, is controversial. This assumes that a weakness in one method will be compensated for by another method, and that it is always possible to make sense between different accounts. This is unlikely. Triangulation is used to ensure that an account is rich, robust, comprehensive and well-developed. A single method can never adequately shed light on a phenomenon. Using multiple methods can help facilitate deeper understanding. (Denzin, 1978, pp. 339-357) identified four types of triangulations: 1) methods triangulation 2) triangulation of sources 3) analyst triangulation and 4) theory/perspective triangulation.

For this thesis, first theory/perspective triangulation was performed by comparing theoretical data to white spots in research.

Secondly, triangulation of sources was performed by comparing empirical data from two of the largest, data driven companies in Norway- one from vendor (Equinor) and the other from supplier perspective (Kongsberg)- both frontrunners in their respective fields. Both the sources (data from a supplier and a vendor company), different viewpoints (Interviewees from both management and employees in various departments) where utilized. This was compared to an in-depth interview with a highly relevant source from SINTEF.

As Lincoln et al point out, confirmability is a degree of neutrality or the extent to which the findings of a study are shaped by the respondents and not researcher bias, motivation, or interest. In this study, confirmability has been strived for by utilizing triangulations, a priori themes extracted from gaps in theory and review articles (and a workshop summary) and template analysis as method.

Additionally, reflexivity was added in research perspectives, positions, values and beliefs where suitable as best as possible, to show how the researcher's preconceptions, beliefs, values, assumptions and position may have come into play during the research process.

Transferability and external validity

Transferability in qualitative studies differs from the way it is ensured in quantitative ones which may randomize the selection and probability reasoning. In qualitative studies, transferability is ensured by a thorough description of the studied situation so that the reader may evaluate the applicability to other contexts (Mehmetoglu, 2004, p.

181). For this reason, thick description was added. (Lincoln & Guba, 1985, p. 345) describe thick description as a way of achieving a type of external validity by describing a phenomenon in sufficient detail one can begin to evaluate the extent to which the conclusions drawn are transferable to other times, settings, situations and people.

Choice of Method

Methods are the tools and techniques that are used in the collection and analysis of data. As outlined above, the philosophical background to research can determine the types of methods that are appropriate. Once the most appropriate methodology has been identified, there are likely to be methods specific to that methodology. As with the choice of overall methodological strategy, we should use the methods that are best suited to answering our questions about a phenomenon (Busch, 2021, pp. 53-54).

Interviews are the most common method of obtaining phenomenographic data and were decided as the richest means by which the interviewees' perceptions could be explored via their accounts of experience. Focus group interviews were chosen to allow the interviewees to share their experiences and build the discussion around them without being influenced by the researcher. This also allowed a cross section of ages, genders and previous experiences to allow for variation in the perceptions. The interview questions were semi structured and open-ended to allow for discussion.

The aim was set to develop state of the art advice for a new industry standard within digitalization and OSH. Two global corporations (Equinor and Kongsberg), both front runners in the digital strategy field, were chosen for the focus group interviews. These findings were then triangulated with an in-depth interview from SINTEF, one of Europe's largest research institutes.

A phenomenological approach was chosen with the aim to develop new terms and to understand more of the existing terms. The data from existing theories, the literature review and the focus group interviews from them was triangulated against each other.

Equinor was chosen as a representative for the end user perspective and Kongsberg for the developer/supplier of digital and autonomous systems perspective. To explore the main question "**How can one avoid sickness and absence caused by utilization of machine learning (AI) in work life?",** a qualitative research methodology was employed.

The context for the study was the current phase of machine learning (AI) development, and the two chosen corporations were both global, data driven and front runners in digitization and had set the industry standards in many areas. For this paper it was important to collect data from both, as Equinor represented the end user perspective where Operational Planner Tools, Permit Vision and Digital Field Worker to name a few, were being implemented and used whereas Kongsberg stood for the next level testing and delivery of autonomous systems in various fields as shipping, defense systems, aerospace, artificial intelligence amongst others. SINTEF, in this thesis, represents the developers of algorithms (machine learning (AI)) for companies and industries, supported economically by the Norwegian Research Council.

The focus group interviews from Equinor and Kongsberg, despite great efforts, were performed with four and three interviewees respectively. Although the numbers of participants were less than the minimally recommended (5), thick description should confer some transferability and external validity.

The ethical guidelines of the university were implemented throughout the research. The interviewees were given written and verbal information clarifying that the participation was to be fully voluntary, and the consent could be withdrawn any time without any repercussions. Consent was received in writing. The researcher had no previous work experience with any of the interviewees.

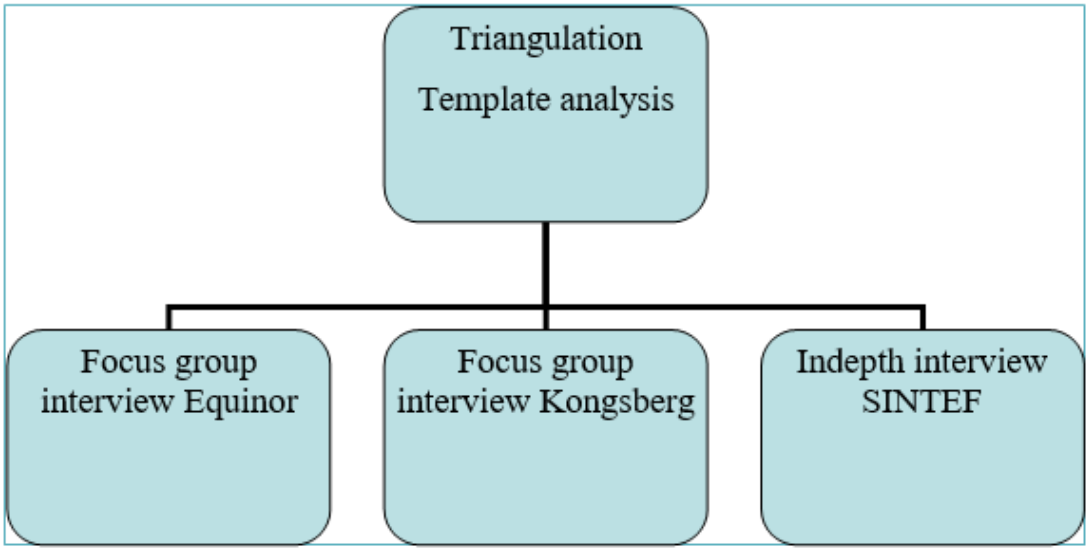

Figure 7 Research method

3.1.3 Data collection

Choosing the review articles from the search results was a challenging process due to the fact that much of the research was done in specialty fields as hospitals, commercial or purely IT industries and so forth, as well as much being outdated in terms of the current phase of machine learning (AI). Finding review articles that contained OSH perspective as well as being broad in their scope with regard to different areas and industries, in addition to being adequately recent to encompass the current phase of machine learning (AI), became a time consuming but rewarding process ultimately. It may though have added researchers bias in selection, but the researchers broad background as an occupational physician from industrial, knowledge workers and health industries might have counteracted some of the bias.

Table 1 summarizes the search words used to find review articles (and a workshop summary) within this topic and the white fields on the theoretical map that they mention. The latter, combined with the theoretical main perspectives mentioned in Chapter 2 give basis to the empirical part of the study as the main assumptions under the main research question and in the form of focus group and in-depth interview questions.

3.1.4 Challenges of data analysis

(Maxwell, 1992, pp. 285-295) identified five different types of validity in qualitative research: descriptive, interpretive, theoretical, generalization and evaluative. Descriptive validity is that the researcher does not embellish or distort the information, situations and facts reported are those that were seen and heard. The interviews in this thesis were recorded and transcribed word by word, and where there was uncertainty, they were corrected according to the physical notes taken during the interviews. Although translating the quotes from Norwegian to English may confer a bias, the researcher's bilingualism could weigh up for this as well as choosing a native English speaker for the proofreading. The selection of quotes may have conferred another bias, also during coding and analysis, but the constant process in the template analysis (Chapter 3.1.2) would counteract this. Credibility was attempted by triangulation of sources and theoretical perspectives. Thick description was added for transferability. Possible researcher bias was discussed continuously under the appropriate points.

Template analysis was utilized for the empirical data. A priori themes were defined as shown in Table 2 and Figure 6, based on the themes from the focus group interview

questions. The interviews were transcribed and thoroughly examined. Coding was performed in NVIVO. Initial coding of the data was performed and transcripts relevant to the research question were identified. When the transcripts were encompassed by one of the a priori themes, the code was “attached” to the identified section. If there were no relevant themes, an existing theme was modified or a new one was formulated.

An initial template was produced after a subset of transcripts had been coded. The themes identified in the selected transcripts were grouped into a smaller number of higher-order codes which described broader themes. The template was then developed by applying it to the full data set. If a relevant text did not fit in an existing them, the template was modified to accommodate that. The final template was utilized in interpreting and summarizing the data. During each tier of coding, quality and reflexivity checks were performed to ensure that the analysis was not being systematically distorted by my own preconceptions and assumptions.

The deductive part consisted of exploring existing theories within main fields to test the assumptions under the main question and comparing with the results from the focus group interviews. The following factors were chosen regarding the potential to lead to adverse health effects that again may lead to sick absence: 1) Autonomy (freedom in task execution) 2) Tempo regulation 3) Personal and role conflicts 4) Emotional reactions and psychosocial reactions when machine learning (AI) is introduced and 5) Cognitive regulation (capacity to learn).

Finally, a last question was added to these asking the interviewees for what factors they may consider changing to lessen the negative and strengthen the health promoting reactions in employees.

From the main research question to the assumptions and down to the focus group interview question, the researchers bias might influence the a priori themes. This was addressed by triangulating not only the theoretical data but also the company and industry perspectives from vendor, buyer and one of Europe’s’ largest research institutes. In addition to this, the a priori themes were adjusted during the coding and subsequent coding was modified accordingly.

The challenges of explorative research were handled by structuring the nodes and following strict protocols for coding. The interpretation and classification of data was subsequently performed in the same structurization.

Teams was used for the focus group interviews and although it allowed a more practicable interview process, there are some threats to the validity of data that must be mentioned.

Even though video was on, the interviewees were not able to observe each other's full body language and thereby fully utilize non- verbal language to gage their reactions to each other. This may have influenced some of their replies to each other. The researcher, likewise, was unable to constantly observe these reactions and interpret them fully. (Bryman, 2012, pp. 659-666) argues that body language, reactions and emotions are important as a cue to what the interviewee may not be telling us and may be missed in a digital interview. A digital platform was chosen because of the Covid19 pandemic and later for practicalities due to different locations, but one may have missed some data collection opportunity via observation.

Additionally, sample number of interviewees from the focus group interviews pose a challenge in terms of sample size as well as only one in-depth interview from SINTEF (although the source and SINTEF both probably have the most experience on this topic).

3.1.5 Ethical considerations

This study has been approved by Norwegian Centre for Research Data (NSD) and is compliant to the Norwegian national research ethics committee's general guidelines of confidentiality, impartiality, integrity and good reference practice amongst others (The Norwegian National Research Ethics Committees). Appendix 2 shows the NSD approval. The interviewees have been recruited voluntarily and the researcher had no direct, professional or private connection with any of the interviewees. They all signed a consent form declaring that the study was executed in the researcher role and not as an employee in the mentioned companies. The consent form contained an information letter according to the regulatory demands. This was confirmed by the interviewees in the recordings. Data collection and storage was following GDPR, and confidentiality and the recordings would only be stored as long as the study lasted on a third-party server approved by the University of Stavanger and NSD. Data was anonymized, and the encryption keys were kept separate. The data was only accessed only by the researchers and the researcher's mentor. The interviewees were informed that they could withdraw their consent without fearing any consequences to the professional relationship to the researcher. Furthermore, no personal information was collected.

Extra precautionary measures were taken by the researcher. During the focus group interviews via Teams, the interviewees were told that the researcher would only address them by the first initial of their respective names during recording. The interviewees appreciated this extra measure as Teams necessitated raising the hand function and subsequent calling out by the researcher for the next person in line. The interviewee from SINTEF, since it was an individual interview and did not have the support from others like in the focus group interviews, was offered to read the quotes and context before publishing (interviewee accepted and commented any clarifications).

Additionally, the recordings on the third-party secure server were deleted after transcription. The interview guide, an example of the interview transcript (Appendix 2) and a table of findings (Appendix 3) were added in the appendix of this thesis to add most transparency to the procedures.

4 Results

This chapter consists of the empirical findings from the focus group interview from Equinor, the focus group interview from Kongsberg and the in-depth interview from SINTEF. A structured overview of the interview questions, the corresponding theoretical dimensions and the findings are depicted in figures 8-12 in Appendix 3. The following paragraphs are summaries of the most important findings along with thick description from the respective interviews.

4.1 Focus group interview from Equinor

How can one avoid sickness absence caused by utilization of machine learning (AI) in work life?

The contextual backdrop for the focus group interview in Equinor was a recent organizational change and a companywide strong data strategy that was completed in recent years.

Equinor had been organized as a matrix organization for several years. Employees had traditionally had long careers in the company. There was a strong culture for collaboration and knowledge sharing. Continuous mobility across areas, in or around projects and agile teams, allowed for a more extensive experience transfer in shorter times in the company than without such a culture.

Several possible interviewees were invited to an initial, short informal discussion (1-1) on the topic of this thesis. This allowed for an open discussion where topics as time in the company, rotations, experience with digitalization initiatives, robotization/machine learning and so on where approached. Out of these, five agreed to participate in a Teams based focus group interview. Their experiences were long, diverse and different from each other's and thus contributed with different angles into the questions discussed. After the interview had started recording, one of the interview subjects sent a chat message that there may be delays so the interview started with the hope that five members would participate. Unfortunately, the focus group interview had to be performed with only four interviewees.

Q1 How may we ensure that employees have adequate freedom to describe their tempo of work and sequence of task delivery?

The first comment set the context in the operation groups of central control room operators that are (according to the interviewed group) known to be under a lot of pressure when it comes to many aspects and are continuously developing new tools and working with the simultaneous use of these. For Equinor, these operations groups are in the front face of this dimension and tempo is a key word in addition to this. The following quote highlights this, and the interviewee shared the frustration felt during observation of the groups while digital tools were continuously being introduced to the groups without the necessary time (in some cases) to learn the tool or application fully.

*"It is possible to design the systems in such a way that they contain a **sensible task sequence**, and a sensible timeframe for the operators to relate to. That we can design in, we can **design in delays** for example, if we think the operators need longer time, that is one possibility. (Interviewee 3)*

Control of task delivery sequence was also mentioned in this context:

"…so that which sequences will come, that you are prepared for what is coming…because it is always stressful when you are not in control, when you don't know what the next step will be…" (Interviewee 5).

The other Interviewees agreed and found **autonomy and support to override AI** crucial, even more so in remotely operated installations so that the operators remain engaged.

*"That is, if an operator is standing in front of a **black box** which is telling the operator to not shut down the system and just keep production to normal levels, and the operator thinks* (Interviewee 3 in a hesitating voice) "*I think the black box is wrong, I think I need to shut down". In situations like this, the operator needs to know that someone's got his back. He needs to know that it is something he can do without fearing negative consequences for himself...And that support needs to come from the management." (Interviewee 3)*

Interviewee 5 added that even though this was a new area to said person, Equinor's management principle of empowerment addressed the possibility of both having the opportunity to be in control of one's tasks in one's own time and having the trust to do so. The other interviewees reflected on interviewee 5's quote above from different

angles- such as having the **psychological safety** to cease production, despite knowing that it will cause millions in losses. Bearing that in mind, interviewee 5 found it crucial to design the systems in such a way that the employees have the **autonomy** they need and **are in control, and not being controlled by the systems.**

Q2 How may we ensure that the expected tempo of task execution does not represent a health risk?

The interviewees needed to think a little while on this question, and as they slowly eased into the discussion, aspects as both high and low tempo, fluctuating tempo, knowing the task sequence to be able to adapt to the tempo as well as being able to control the tempo were highlighted as important points in this discussion.

One aspect raised was **individually adapted task tempo**. The group deliberated that

*"(It is) important that it is the **human**, that is the one sitting and operating, is in control over work tempo and the sequence of deliveries so that the design ensures that it is not the machines and the system that is steering the employees, but that one manages to design this in a way that the employee is the one in charge, that is crucial."* (Interviewee 5) This was supported by Interviewee 2:

*"…this is in relation to … what is expected of one, and what terms exist regarding how fast one should respond or to take action. So, I think one should also see this in relation with the tasks having been **individually adapted**…so that one can keep up."*

*"…one thing is having **too much to do**, that may be a stress risk, but it is a point that it may be an equally large risk to have **too little to do**, both in terms of motivation and attention…that is also valid here, I think both sides are relevant as we already discussed…and then the question of how we ensure- that is a good question- that one is in control of the operation…that is at least a pre requisite to be **able to control** (slowly puts emphasis on control) **the tempo**…*(Interviewee 5)

The other interviewees agreed upon this but added that it is important that the order of task execution is adapted to a manageable degree, and that the operator feels comfortable with them, has adequate training and control over the execution. This made interviewee 5 add to the quote above:

"…both learning and training in the tasks is necessary to be prepared, as with crisis management or emergency preparedness training offshore, and have this training as

*reflexes when needed- this could also help being prepared for a changing tempo and handle this sort of dynamic better…" (*Interviewee 5)

In addition, some shifts may experience low or monotonous workloads, and this could affect engagement, attention and ultimately safety. Interviewee 3 pointed out that the switching between very high workload and very low workload was seen to taxing on one of the control room operated installations and, in this case, technology could be used to program a more reasonable workload.

Q3 The introduction of machine learning may cause conflicting demands or personal conflicts between colleagues and/or leader- how may we reduce the risk for this in the workday?

To avoid conflicts between workers and/or management, the group found it vital that the employees understand what the technology entails, how it will be used and what it will represent for them as workers. They found it especially important to clarify how it will change tasks and the distribution of these amongst the different job categories. The interviewees argued that in some cases, the introduction of new technology might even remove some conflicts and frictions between groups and may even lead to a more meaningful and educational workday. In other cases, the group argued, the introduction of new technology itself didn't cause new conflicts, but instead existing conflicts in the psychosocial working environment were blamed on the new systems or tools.

"…in certain contexts, the introduction of new technology may ***remove*** *(existing) conflicts and frictions, and contribute to the employees attaining a more meaningful and educational work situation" (Interviewee 3)*

"Sometimes, the introduction of new technology/tools may ***trigger*** *an already* ***existing*** *conflict, but that has not surfaced yet…Cause and effect are more complicated, I think, than new technology causing conflicts….I know of one workplace in Equinor where the introduction of a digital field worker unit* (app on mobile device) ***generated a lot of noise*** *than other places…When we looked closer, there were other, existing, issues in the psychosocial working environment that were not being managed, and this digital field worker unit was then blamed for everything in working environment committee meetings and so forth…so the way this workplace received this digital field worker unit, reflected somewhat the* ***emotionality that already existed there****.."* Interviewee 3

Q4 Employees may have different reactions to change- what type of emotional and stress reactions do you see in employees when machine learning is introduced?

The group agreed that machine learning (AI) had deprived the operators of some of their tasks already, and even though they may be left with more meaningful tasks, it was often seen that the employees feared for their tasks and workplace. Stress was seen in the form of questions as "what is my place now?" and "what does this mean for me?". These types of reactions were interpreted as a feeling of **job insecurity** that in some cases lead to employees putting off tasks related to this lack of job safety so to speak. Fearing consequences if black box decisions were overridden by the human intelligence, added to this type of feeling of job insecurity.

*"…what we see often is that employees become **afraid for their tasks and workplace**, and **insecure** of what their place will be going forward, and this may be felt **as stress**." Interviewee 5*

*"General insecurity, and the reaction may be to postpone the tasks related to it because one lacks the security for it, one feels one cannot manage it…and I think one may **feel lack of an adequate training** in the new tools which may be many and come with maybe a five-minute online learning…additionally, as mentioned before, having many of these programs to relate to makes it **hard to have a good overview over and leads to stress**."* Interviewee 2

*"**Fear and stress**, obviously. Also, a form of **irritation,** when one has to interact with these tools, chatbots and robots that ask you to speak clearly, and automatized systems that all of a sudden seem like they want to do something else than what you expected…In addition, you in a way acquire almost a new set of "colleagues", that behave differently than what you expect sometimes, and are irritatingly stupid in many contexts….sometimes, the developers of the tools use their customers as beta testers of immature apps and only correct each version after receiving complaints, so you expose the end users to **unnecessary frustration and stress**."* Interviewee 3

Another issue raised was the **perceived loss of productivity** initially when the tools are implemented which also could lead an emotional response and stress.

Q5 What kind of recommendations would you give to improve the employees' capacity to learn in this setting?

One interviewee argued (to the unanimous support from the other interviewees) that the problems are not caused by individual digital tools. It is rather the **cumulated effects of the digital tools** that are presented in the organization, to the employee, with the **expectation of training in them without necessarily having the time to learn** each and one of the tools well enough to use them well. To counteract this, **designing good user interfaces that accommodate these cumulative effects,** are going to important the group argued.

"But, if I may say, in general the problem is, perhaps not specifically for machine learning but pertaining the way we introduce (digital) tools in the organization, that they may or may not receive training in, that they have to learn to use- but use seldomly. Because there are too many tools for them to be trained well, so I think that we may achieve this for singular tools with good interfaces, but in my opinion, it is the ***totality*** (emphasizes this slowly) *that is the problem. Our operations groups operate in between 30 to 40 different (digital) tools that they use for production optimalisation and so forth." (Interviewee 3).*

The discussion revolved around both **emergency preparedness and crisis management training** and were further elaborated on as both **being prepared for the tasks and to the shifting tempo**. Further, the interviewees argued the importance of learning and **training** that takes into consideration which level you are on. For example, where employees undergo testing beforehand to assess which level they are at and then receive **individually adapted learning**.

In addition, they argued, having the opportunity to actually try out working as you would be in the end was important, not just on pc or a whiteboard, but being allowed to actually see the possible results as they will look when you actually do the work. This would be achieved in a **simulator training and virtual training**, especially for control rooms since it may be long periods between situations where they may be needed. The group agreed that the time between those situations should be spent on regular trainings in simulators and to familiarize oneself with the room and equipment.

"Two things I think of are adequate time for learning and training on simulators where you may get a feel for the actual results of your work are essential". Interviewee 5

To this Interviewee 3 added:

"...the employees working in central control rooms of remotely operated installations, may have long pauses between performing certain tasks, so what was said about simulator training is crucial. They should be allowed to use the time in between these task to train in simulators. Luckily the company has a lot of good ongoing work on this already." Interviewee 3

These comments were supported by Interviewee 2 who added that training for different scenarios in these virtual training sessions would be essential and that what was said under the previous questions about individually adapted learning respecting the level that the employee is on would be necessary. This could be achieved by pre-testing the level for each employee and then adapting the learning to that level. The other interviewees added that it was important to adapt this to the needs of both young and ageing employees and also to the workload from existing tasks and training.

Another crucial aspect raised was the need for **regularly updated experience from the physical work environment.** This was explained as the need to be familiar with the physical environment of the installations you are expected to control remotely. It was argued that this can be achieved only with regular trainings in the physical environment from such installations. In order to respond quickly in emergency situations in the control rooms, it was seen as important to be familiar with the physical environment/systems on the installation so in an alarm situation unfamiliarity to the physical installation would not add to the stress.

Two interviewees agreed (both verbally and with nodding during the discussion) with Interviewee 3 and added the importance of early **involvement** of end user groups when implementing new technology.

Q6 What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?

By the time of this question, the group felt that all aspects had been covered already, and one member said jokingly that what they discussed in prior this was so good that they did not have any new points on this question. The group laughed in unison at this remark.

To reflect on this, it was decided to summarize the points already mentioned by the group and a few more points were added or clarified (figure 9, appendix 3).

Communication and competence were areas highlighted in the discussion:

"The first thing that comes to mind is ensuring that the person partaking in the work process has an adequate understanding of what is going on, why it is happening and the machine learning process…the latter will for many be a black box…so to have a ***conceptual understanding of how things work*** *will contribute to create an understanding between the colleagues…so that when things change drastically (which happens when more data is collected), if one is not up-to-date on the changes, it may potentially create conflicts among colleagues…As for the employee-manager relation, it is important to give adequate space and* ***trust*** *the operator….It is also crucial that the operator understands the bigger picture, as to what risks lie in for example a control room, what consequences one risks if one does not shut down. Even though one may not understand everything inside the black box, the* ***operator should be able to see this bigger picture****." Interviewee 5*

This Interviewee (Interviewee 5) was asked to elaborate on how one could create this "conceptual understanding" mentioned in the quote above. The response was to explain the operations within the black box to **show the potential consequences of the operations, in a simple, non-technical manner** that may be understood by the operator. Interviewee 3 and 4 agreed on this, but added:

"I was thinking that it is important to ***clarify*** *the work tasks, because they may change going forward, and the distribution of these between disciplines may change as well. So, to avoid conflicts, it is very important to* ***clarify beforehand****, so one does not end up with conflicts as to who is to perform what…We had a situation on an installation where management, in quiet periods, wanted a shift to perform tasks belonging another shift, but* ***that*** (raises the voice decisively) *the first shift did not want to do, they wanted to perform tasks that belonged to them. In this situation, it had not been clarified beforehand, and the employees did not* ***agree*** *with management on how to do it and they became very* ***negative.****"* Interviewee 4

"…and as several of us mentioned, ***involvement****, that the tools are not forced upon the workers but instead they should be allowed to participate in deciding how these tools will be used in their workplace…we have many good examples of this from central control room design where operators participate in the design group and experience*

transfer from other projects is utilized. In addition, safety officers and the working environment committee play active parts in this." Interviewee 3

On the topic of **work organization,** clarification of tasks and division of them between groups of employees was raised as important to avoid conflicts.

"I think in general with change processes, it is a rule to create understanding for **why** things are done, why the change is effectuated and why things are introduced…so that one sees the bigger picture, than just the one operation you work on…management should explain why the change is needed for the company, this should be anchored throughout the company levels and be explained to the workers in addition to involvement…" Interviewee 5

The group discussed **system design** and its underlying, important factors to prevent stress such as a sensible task sequence and sensible time for operators to execute the tasks by for example designing in delays in the systems where necessary. As mentioned earlier, **not exposing the end-users to beta testing of insufficiently developed software** for example was yet another example.

Good user interfaces and apps/tools that were intuitive and "felt sensible" to the users were also emphasized and involvement in the development, introduction and implementation by both users, safety offices, work environment committees as well as management were highlighted as crucial. Having a solid foundation of information from workflows and processes, tasks, existing software and system were seen as important to be able to design new, functional tools and systems and the group suggested a **virtual task analysis and human centered design** for this. This was also important to avoid the users becoming "beta testers" for the software. Another factor that was raised as crucial was **building in the override ability for human intelligence to take over command from the system, when necessary**, but for this, the group found it essential that **management gave clear and full support** for it without the employee fearing reprimand in retrospect of such situations.

4.2 Focus group interview from Kongsberg

Q1 How may we ensure that employees have adequate freedom to describe their tempo of work and sequence of task delivery?

Interviewee 1 opened the discussion by suggestion that machine learning (AI) should perhaps be used as a **template** for planning of the various activities and be adjusted with **input** from the resources.

""I was thinking that perhaps we must use machine learning ***(AI) as a template for planning*** *the various activities. Then we have to adjust it to the employees' needs, because a resource is not a machine (*raises voice). *Then I'm thinking both of the speed one executes the tasks, the quality one delivers, whether one is experienced or relatively new and if one has many tasks in parallel. Maybe it could be a prize that one also says that this way one may protect the resources against many parallel tasks."* Interviewee 1

The other interviewees agreed and emphasized the importance of involvement in planning and respecting the differing needs for example task specification and instruction, experience and tempo of delivery. Involvement was also seen as important as it could cover both tempo and task sequence and thereby contribute to the preventive health aspects.

"Access to information and knowledge could also be added here. Let's say I am new, having no network in the company or in the project…then it will be difficult for me to acquire the information or knowledge I need to perform the tasks. As opposed to person X who has been in the company for years and doesn't really need to search for knowledge. This person may contact the right people directly and get answers quickly." Interviewee 2

Q2 How may we ensure that the expected tempo of task execution does not represent a health risk?

"One way to do this is that those planning the conditions for a project or an internal work process, have a relation to what the task is. If one does not have that, one must have a dialogue with those who are going to execute the task as Interviewee 2 also mentioned. This is to try to find, to try to understand how long it actually takes. Because if the set time estimate is unrealistic, it will quickly become a health risk." Interviewee 3

The other interviewees agreed, and Interviewee 1 added other dimensions as the importance to follow up during the process to pick up unforeseen or unexpected events and correct the course to avoid health risks as for example resources working around the clock. Also, this Interviewee added that even though one is expected to automatize, it may not be possible to do so completely without manual corrections to avoid such risks.

"I think one has to take the time to follow up during the process, because unforeseen or unexpected situations will always arise. To be able to help with corrective actions, to avoid health risk or stress from for example working around the clock. Not everyone dares to speak up, in cases like that I think it would help to make a plan before it becomes a crisis. But I think (giggles a bit) this is a bit hard to think of in terms of AI, that is a challenge. Machine learning (AI) is automation, and we are supposed to automate without too much manual influence or interruption, but I don't think we can avoid manual interruption. The manual interruption might contribute to adjusting the machine learning or a part of it." Interviewee 1

Q3 The introduction of machine learning may cause conflicting demands or personal conflicts between colleagues and/or leader- how may we reduce the risk for this in the workday?

"This is a well-known problem, and it doesn't have to be due to machine learning, it may be a robot or something like it in its simplest form. Something that comes and threatens the job security to that person, and that may be a worker or also a leader. In the past years we, as a society, perhaps thought that artificial intelligence would take over only the "stupid" tasks. But we have seen through data analytics that it may take over leader roles as well. We also have self-management to a larger degree, where people are autonomous and don't need leaders. The correct thing to do, in my opinion, would be to ***include*** *people so that they may understand…..Including people would also contribute to give them a feeling of security and understanding rather than them feeling threatened. Include them in an early phase, the earlier the better- that is, actually listening to what they have to say, don't just say a change is coming."* Interviewee 2.

Interviewee 3 agreed and added that new competences will replace old ones, and the ones being phased out, as for example due to more automation on the Norwegian continental shelf (offshore), will make certain jobs superfluous or shifted to onshore locations. The risk for conflict in that, interviewee 3 added, could be reduced by securing these workers with for example reskilling or by giving them other relevant and

meaningful jobs even though their current jobs may be automatized or replaced by a form of artificial intelligence. By having a proactive measure like this, threats like these may be reduced.

Interviewee 1 also supported Interviewee 2 and added that by showing the support machine learning may provide the workers to perform tasks better, by reducing the risks of making mistakes.

"...you may have less responsibility then, so you don't have to be afraid of mistaking mistakes, but you now get a support from tools that reduce the consequences of mistakes. Then it will be positive to utilize these." Interviewee 1

Q4 Employees may have different reactions to change- what type of emotional and stress reactions do you see in employees when machine learning is introduced?

Interviewee 1 opened the discussion by describing the simplest form of reaction as skepticism that may materialize as employees not caring about milestones in projects. Interviewee 2 added job insecurity due to a fear of machine learning replacing jobs since knowledge about machine learning may be lacking.

"If one does not provide adequate training, one will not experience mastery. They (employees) may then give up or try to oppose the new (machine learning)…I think training is the keyword here."

Interviewee 3 agreed and added:

"Another thing is to introduce assistants in the form of new (machine learning) tools, that may make the employee better and more effective. More a form of synergy then, and using humans in what they are good at, and machines for what they are good at." Interviewee 3

"Yes, I have seen strong attempts at counteracting machine learning, (digital) assistants, tools, digitalization. Two things are recurring (themes): job insecurity and not feeling mastery because you are used to the tools you already have and new things come and change that….Then next week, newer tools may come, so they (workers) don't care about what you are talking about now. More frequent degree of changes may also contribute to introducing stress. That is something one should admit in large organizations that have a rapid rate of change." Interviewee 2

Q5 What kind of recommendations would you give to improve the employees' capacity to learn in this setting?

The individually adapted time and resources needed to implement changes was discussed.

"What comes to mind immediately is that people should get the time they need to learn, or to contribute to change…We must give people time and resources to embrace that change". Interviewee 2

"And I think it is important in that type of change processes that we are talking about here, that you manage to communicate a common understanding of why (puts emphasis) you are making the change). Interviewee 3

Interviewees 1 and 2 agreed and added the importance of using early adapters as beacons that often have credibility in the different layers of the organization to convey the change. Using these beacons for lateral learning would be beneficial to reduce some of the skepticism in others the group agreed.

"*Using some "beacons of change" as role models, some that are positive (emphasizes and raises the voice), to join and advocate the change processes. Then later have gatherings with the rest for experience sharing, showing how one changed the way to work, share with the ones who might be struggling or haven't started yet."* Interviewee 1

Q6 What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?

The group discussed the equal importance of leaders utilizing machine learning to plan and allocate resources to avoid a mismatch between manual allocation of resources from many leaders to singular resources that then may be overbooked.

"This demands equal work from the leaders as well, for them (employees) to follow and utilize it (tools). Automating the resource booking would be helpful, to avoid that 4 leaders don't allocate the same resource. This way, we could ease the way to find other resources when one more easily can see what resources there are to choose from." Interviewee 1

In addition, involving the users directly affected by the change, was seen as crucial as it may add to a sense of autonomy to be included in the change processes from the early phases.

In projects, it was suggested to give more time in the beginning so employees could learn new (digital) assistants or tools, for the human-machine interaction and interfaces to improve.

"I would give them more time in the start phase. If they get more time to change and learn in in the start phase, it will contribute to the knowledge level and abilities over time and then you may save that time in the end of the project." Interviewee 2

Utilizing informal figures of authority to communicate the benefits of the change, as mentioned earlier, was emphasized. Additionally, visible support and communication from top management throughout the organization was given importance.

"In my experience, visible top management and informal figures of authority on several levels in the organization may be a positive thing as well. If they can speak and show that the change is positive, ...people may be more receptive of change if top management is visible during implementation." Interviewee 2

4.3 In-depth individual interview from SINTEF

SINTEF is one of Europe's largest research institutes, with a mission statement declaring "Technology for a better society". According to the interviewee, recent years advances have been in reduction of CO2 emissions, circular economy, reduced energy consumption, improved utilization of resources, digitalization and digital transformation amongst others. The Research Council of Norway (RCN) receives funds from the state budget which it distributes to various strategic programs. Companies interested in solving specific problems contact SINTEF, and together they may apply for funds from the RCN. The Research council is interested in seeing that the research comes to benefit across industries.

Q1 How may we ensure that employees have adequate freedom to describe their tempo of work and sequence of task delivery?

The interviewee started by explaining that the team from SINTEF worked with development of algorithms and most of what they made was material for decision support. When asked if these algorithms for decision support contained settings that may change or influence framework for the tasks the solutions were being developed

for, an example from an ongoing project was given: When building roads, large machines typically have an engine idling of 40-60% of the time. To optimize resource utilization, the project was developing data collection algorithms. When the work processes were effectivized, this would reduce engine idling, potentially increase the work tempo although reducing idling might interest the workers as well.

When asked if there were any settings in the algorithms or programs that may allow the employees to describe the tempo, freedom of task execution or autonomy themselves, the answer was that this was not something SINTEF had been working on in this project or similar projects to the interviewee's knowledge. When asked if settings like these needed to be initiated by the companies or employers themselves, the interviewee replied:

"At least, it would have to come that way. We work mostly with finding bottlenecks in the system, where is the potential to be extracted, to work both more efficiently, reduce idling, that part of it."

When asked if the algorithms considered the dimension of parallel tasks or if the tasks were considered sequentially, the interviewee replied that it was sequential.

Q2 How may we ensure that the expected tempo of task execution does not represent a health risk?

The interviewee described another project where packing of pallets with goods was being aided by robots. In projects like these, the team looked to remove some **D**'s from "**D**irty, **D**angerous or **D**ull". From lifting heavy loads during a workday, the project sought to reduce the musculoskeletal strain on employees and optimize packing to reduce need for transport:

"Here, one wished to avoid that (wear and tear of employees due to heavy lifting), and then you would perhaps acquire a different task, maybe following a robot to ensure that it does the job correctly instead of you doing all the lifting yourself."

The example from Question 1 described the tempo as well.

Q3 The introduction of machine learning may cause conflicting demands or personal conflicts between colleagues and/or leader- how may we reduce the risk for this in the workday?

The interviewee mentioned a project where truck drivers logged distance driven on iPads and received feedback if they drove in a more environmentally conscious manner (by keeping the tempo evenly), while logging where they drove.

"You would think that they felt monitored, but I don't think so, they (companies) are very conscious of GDPR (regulations), so it won't happen. But you could imagine that you may receive smiley faces if you drive environmentally friendly, or that you receive suggestions to be careful with accelerating in an uphill because then your CO2 emission is higher than if you drive in a more even tempo. We haven't been involved in it, but I know that the customer is very careful about handling GDPR regulations. Meanwhile, they use the system to receive payment for how many loads the truck has driven, so what they do needs to be logged as well."

Q4 Employees may have different reactions to change- what type of emotional and stress reactions do you see in employees when machine learning is introduced?

"I think, generally speaking, that people are more positive to change if they have been involved in finding out how the system should be made. If you feel that you have been involved in influencing and developing, that these are things that are useful to us and things that are not so (puts emphasis) useful. Then, I think people are generally more satisfied with the change or how it may help you. That, I think, is independent of whether it is machine learning or whatever it may be…"

The interviewee also mentioned that their customers were the ones taking initiative to start the projects, but the teams (SINTEF) had discussed implications before the projects started. One such implication was the potential for job losses for young people in certain rural areas.

"Yes, that is something we consider in each case. What we are about to start, how will this influence the job security? But so far we haven't had any cases where we've automatized away from people." (that is, technology replacing humans fully).

Q5 What kind of recommendations would you give to improve the employees' capacity to learn in this setting?

The interviewee mentioned that contrary to common beliefs, old type of competence was still needed in especially industrial workers and many workers still preferred mechanical tasks as opposed to operating vehicles remotely, even in younger generations. In addition, during the SINTEF projects, they sought to involve at least one person with data technical knowledge in addition to one person with the competence from the field.

"What we find useful, is to achieve an understanding of what machine learning is and what it is not. What we work with mostly is analysis, modelling, and some learning from data of course, machine learning. But to understand what the system is capable of and not, especially, it will take a lot for it to come and overtake everything. To get a better understanding of what it is and what it is not, I think a good training is necessary."

Q6 What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?

As mentioned in Question 1, to allow involvement from employees and settings for autonomy and tempo regulation, this initiative would have to come from the companies (employers) themselves from the outset of the projects (algorithm development).

Involvement of employees was also mentioned several times.

Projects as anomaly detection, where algorithms were used to perform tedious and time-consuming tasks as for example inspections of roadside traffic barriers, were mentioned as positive for employees as they could replace potentially dangerous and monotonous tasks with more meaningful tasks:

"..You don't have to spend time on boring tasks as well, for example watching a video of (undamaged) *roadside traffic barriers…If you instead get a marked off area where you have to examine 10 points on a distance of 10 kilometers for example, then you may spend your time on that instead. That is, you may get more meaningful tasks and value creation.*

Table 2 Summary of findings from Equinor, Kongsberg and SINTEF

	Equinor	Kongsberg	SINTEF
Autonomy and job control	Authority and support to override technology if necessary Control of task delivery sequence	AI based template for workload adjusted with user input Equal access to information and knowledge Protect users against many parallel tasks User adapted machine learning (AI) User involvement	Algorithms are not developed with settings for autonomy
Tempo-regulation	Individually adapted task tempo, Workload	User involvement in task planning Planners must have a relation to the task	Algorithms are made to effectivize work processes, for better resource utilization. Parallel dimensions are not evaluated, the workflows are considered sequentially
Role conflicts Personal conflicts	Technostress, Role conflicts, Conflicts between workers and/or management	Competence replaced by needs for reskilling, Job insecurity AI reduces risk of errors, Job mastery	Real time data collection on progress may be perceived as stressful and demands focus on GDPR
Emotional and stress reactions	Job insecurity, frustration, Stress and loss of productivity, Psychosocial working environment issues	Skepticism to change Resistance to change processes, Job insecurity	Decision support Job insecurity Negativity if surveillance is suspected
Learning capacity	Capacity to learn new tools, Sufficient time for learning new tools, Individually adapted learning, Split attention situations	Communication about change adapted to the rate of change, Individually adapted time to adapt to changes, Involvement, Use early adapters as beacons for lateral learning	Competence Experience from the physical environment Training in what machine learning (AI) is

	Equinor	Kongsberg	SINTEF
Settings for improvement	Human centered design, System design, Virtual task analysis, Work organization, Involvement, Communication, Competence	Adjust machine learning with and to the human capacities Allow more time in start of projects for learning Automised Resource allocation Communicate WHY change is necessary Follow up during implementation Reskilling of employees at risk of job loss Share the profits with persons that are losing their jobs Top management involvement in communicating change Training User involvement in early phases Utilize early adapters as role models for change Utilize human assistive machine learning (AI)	Involvement of employees in design Use of technology to give humans more interesting tasks For settings for human centered design to be added, employers must take the initiative when developing algorithms

5 Discussion

The **psychological, sociological and cognitive** perspectives (Chapter 2) highlight some main areas of concern when machine learning (artificial intelligence) is implemented and utilized. These areas of concern are autonomy, tempo regulation, role conflicts, emotional and psychosocial reactions as well as cognitive regulation. Additionally, the literature review pointed to a gap in areas as OSH advice for emerging risks and knowledge gaps for employers on individual and work environment effects. This study's objective was to combine these areas of concern (theoretical main perspectives), knowledge gaps (literature review) with experience-based learning from the interviewees to develop a state-of-the-art industry standard with recommendations for employers and OSH (Figure 5).

In addition, the term psychosocial working environment as mentioned in the working environment act has had several years of development into various directions and is interpreted differently by the tripartite collaboration, and even the labor authorities and the many occupational health services. This very dynamic landscape makes it challenging to observe and delve into the effects of digitalization for even authorities and OSH professionals, let alone employers and employees. Hence the need to concretize advice for the latter based on research and experiences.

Sickness absence was chosen as the outcome for the main research question. Known risk factors within the psychological, sociological and cognitive perspectives were the basis for the focus group and in-depth interview questions. Even though these are all individually known to be related to sickness absence, any one or the combination of many could lead to it, and the direct causation may be difficult to prove. Yet, a literature review by (Michie & Williams, 2003, p. 3) found that key work factors associated with psychological ill health and sickness absence in staff were amongst others a lack of control over work (autonomy), lack of participation in decision making (involvement) and poor social support. Further, successful interventions that improved psychological health and levels of sickness absence used training and organizational approaches to increase participation in decision making and problem solving, increase support and feedback and improve communication.

Additionally, linking any one of these factors to machine learning (AI) at this phase could be difficult as the latter is involved in an increasing number of processes, but in different degrees and in various forms. This could be via algorithms, applications, people analytics, gamification, collaborative robots, digital field worker, Hololens (as mentioned before) and so forth. Several invited interviewees declined the invitation as they did not consider themselves affected by or involved in machine learning (AI), even though a thorough explanation was given about the latter. Nevertheless, an attempt to see the potential effects and outcomes was made.

Another weak point may be the bias – both from the interviewer perspective but also from the interviewees' side. For the Equinor interview, the matrix organization, agile projects and long employee retention as well as a culture for collaboration and rotation within different projects and departments in the company could counteract for some of these biases from the interviewee perspective. Additionally, the interviewees between them, had experience from both onshore and offshore perspectives, covering both physical and office job perspectives. For the interviewer, short experience from within the company (2 years) could be both a bias in the sense of understanding the company's context and culture fully, but also a strength due to the fact that the culture has not fully affected the interviewer's perspective to hinder comparing it other companies. Covid19 also allowed the researcher a quicker rotation within the company (tasks from various levels and departments) to add to this knowledge and made way for a faster introduction to the context. Another positive point was that due to the short time in the company, none of the interviewees had previously worked with the interviewer.

For the Kongsberg interview, not knowing the organization from the inside may be a disadvantage but the interviewees names were provided by their HSE (OSH) department which may provide a better diversification across departments within the topic. Here the interviewer's role as an external leading advisor and occupational health physician from a vendor company may be a possible bias- although the interviewees were informed that the interview was being conducted strictly in the role as an MBA student and not as an Equinor employee.

Both focus group interviews had fewer interviewees than recommended, despite great efforts to the contrary. Thick description may have counteracted some of this. Both groups of interviewees, despite have diverse backgrounds within their own companies,

were in agreement over all topics within their respective groups. This may reflect the phase of machine learning (AI) we are in, having moved on from a patchy introduction to a more even utilization compared to the years before. It may also be due to the small sample size despite the variation within it.

This first review of the results from these two companies showed the importance of having an in-depth interview from a very relevant source in SINTEF, the organization perhaps the most exposed to AI. This triangulation further increased to the trustworthiness of the data.

Of course, the interviewees could have been influencing each other during the interview and the small numbers of interviewees could have contributed to a lack of dissent within the groups. Some of the questions may have been too simple for the groups, judged by the full answers provided and the layers within them. This may have been due to a high knowledge level amongst the interviewees.

The interviews were conducted virtually on Teams, which some challenges as mentioned in Chapter 3..2.2. The interviewer attempted to counteract some of this by giving minimal reactions to the participants and allowing the interviewees to discuss amongst themselves. Another interviewer bias could be conferred by the selection of quotes from the interviews.

Autonomy

Knardahl argued that according to Karasek's demand-control theory, one should develop workplaces where employees have as much control as possible over their own situation. He further argued that this is especially true for those with high job demands, and under periods with high work pressure one should increase the employees' opportunity for control. According to Knardahl, control over one's own worktime is perhaps the easiest to implement. (Mikkelsen & Laudal, 2016, pp. 345-346).

In accordance with this, the findings from Equinor show that autonomy both over task sequence, and over decisions to override machine learning (AI) decisions when necessary, are important. For the latter, support from management when such overriding decisions are made, was considered crucial. (Arnold B Bakker, Demerouti, & Euwema, 2005, pp. 171-172) showed that not only autonomy but also social support from

colleagues, a high-quality relationship with the supervisor, and performance feedback were capable of buffering the impact of work overload on exhaustion. Autonomy may have helped in coping with the job demands because employees could decide for themselves when and how to respond to their demands, whereas social support and a high-quality relationship with the supervisor may have buffered the impact of job demands on levels of burnout because employees received instrumental help and emotional support. In contrast, feedback may have helped because it provided employees with the information necessary to maintain their performance and to stay healthy.

The interviewees from Kongsberg mentioned experiences with users both ignoring milestones in projects, as well as strong attempts to counteract attempts at implementing machine learning, virtual assistants, digital tools and digitalization. They attributed this to job insecurity as well as a fear of reduced job mastery with the new tools. (Brough et al., 2018, pp. 15-16) found that for psychological strain, employees in passive jobs (low levels of both cognitive demands and social support) use avoidance coping to manage their psychological health outcomes. They concluded that where neither the job content nor the job resources can be readily changed then employees may ignore the situation and/or engage in distracting activities (avoidance) in order to manage their work.

Finally, (Rajeswari & Anantharaman, 2005, p. 3127) observed that higher “computer self-efficacy”, that is the belief that one masters computerized technology, and perceived control over technology were associated with less “stress” and work exhaustion. In this regard, control over task sequence could reduce the work-related stress and exhaustion connected to machine learning (AI).

SINTEF: The examples mentioned in the SINTEF interview did not contain any settings in the algorithms where the employee may have the opportunity to describe the desired autonomy. Any such settings, if desired, would have to be requested and initiated by the employers (their customers) to be included in the algorithms’ interviewee pointed out in retrospect (during quality approval of the quotes) that for example in the case of the dump trucks, the drivers would receive a set of tasks from the task leader, and that they did not have much autonomy before the algorithms were implemented either. The algorithms, the interviewee added, would provide the task leader with better decision support.

Tempo regulation

(Christensen et al., 2020, p. 16) argue that the term "stress" could entail a variety of work-related experiences, including job demands and role conflict for example. Following the same train of thought, they argue that "time-pressure" could be considered a "job demand" and "job satisfaction" could be classified under both "work factors" and "health and well-being".

Time-pressure as a job demand, seen in light of the Bakker model (Chapter 2), would demand a possibility of individual adaptation to avoid health consequences. In this manner both high and low tempo could cause stress and a feeling of lack of autonomy if the tempo regulation is not individually adaptable.

(Lee et al., 2015, p. 8) argued that "supply-demand control algorithms were originally designed to solve mathematical optimization problems that involve non-human entities. In Uber and Lyft, however, they are used to motivate and control human behaviors. This causes problems, as the supply-demand control algorithm does not consider the pace at which drivers work". They concluded that "this highlights the importance of making algorithmic management accommodate a) the speed and the way humans work, b) diverse types of motivations rather than only economic ones, and c) emotions that people feel about the decisions that algorithms make". They also found that this highlights opportunities to design structured online social sensemaking of algorithmic features where individuals can build on each other's knowledge.

This is in accordance with the findings from the Kongsberg interview, which highlighted the need for input from the resources to accommodate both speed of task delivery, quality, parallel tasks and take into account the experience level of the user.
SINTEF: Question 1 covered tempo as well.

Role conflicts and personal conflicts

Role conflict arises when one receives contradicting demands from two or more persons, which then leads to a feeling of being pulled into diverging directions during the performing of a task. Role unclarity stems from a lack of a clear definition of the task at hand and arises when the expectations are not communicated clearly enough to the one expected to perform the task (Kaufmann & Kaufmann, 2015b, p. 344).

Implementing technology without clearly communicating why it will be used, how and who will use it, might give rise to both role conflicts and interpersonal conflicts and thereby increase the risks to the psychosocial work environment and affect the individual employee health adversely. In other cases, as the interviewees from Equinor discussed, implementing new technology triggers the existing role conflicts and personal conflicts that already existed in the work environment.

(Christensen et al., 2020, pp. 6-26) summarized in their review article some associations of workers' attitudes towards technology with health, both in aversive and beneficial ways. In some cases, the driver of the relationship seemed to be the fear of a negative outcome, such as technological unemployment. However, there were also indications of perhaps less readily apparent mechanisms, wherein information systems can misalign with workers' personal values, creating role conflict, and in that way promote health problems. They argued that "Finally, once again job control seemed an important factor as the perceived control and mastery over computerized technology seemed to be a factor that can counteract negative health effects".

The Kongsberg interview, in line with the above paragraph, highlighted job insecurity, skepticism and counter reactions to change as some of the commonly seen reactions. To counteract some of these, the interviewees recommended involving and including the employees, communicating how the new tools may reduce responsibility and risk of mistakes, and reskilling the employees at risk of job loss.

SINTEF: The interviewee mentioned that GDPR and monitoring as possible role conflicts but emphasized that the customers (companies) were very careful about handling GDPR regulations.

Emotional and stress reactions

(Salanova, Llorens, & Cifre, 2013, pp. 434-435) hypothesized that the psychological experience of techno strain in ICT users consists of 4 components: anxiety, fatigue, skepticism, and feelings of inefficacy related to ICT use. They divided these further in affective components (anxiety and fatigue), attitudinal components (skepticism) and cognitive (inefficacy). Whereas the affective components gave a feeling of unwellness while using ICT, the other components did not. Of personal resources, mental competences predicted techno strain. They found that social support plays a double role in the prediction of techno strain: the more social support there is, the less fatigue but the more feelings of inefficacy will be experienced. When users get social support from

others (colleagues, supervisors, etc.) while working with ICT, they feel less fatigued and exhausted due to this social support. However, they can also feel inefficacious, as they did not solve the problem by themselves but with a little help from others.

(Christensen et al., 2020, p. 21) concluded that "Overall, technostress creators were associated with psychosocial work environment factors typically linked to negative health outcomes, whereas technostress inhibitors were associated with psychosocial work environment factors often linked to positive health outcomes". Job burnout and job engagement were also associated with both facets of technostress (Srivastava, Chandra, & Shirish, 2015, pp. 376-378).

Conversely, (Luchman & González-Morales, 2013) argue that the focus of cognitive job demands (e.g., problem-solving) is closely aligned to the active learning hypothesis of occupational stress models described by the JDC-S and is, therefore, positively associated with work-specific outcomes such as work engagement. Thus, motivation and engagement are produced when mastery of these cognitive job demands occurs.

Reduced job engagement was also seen in both the Equinor and Kongsberg interviews as a consequence of a feeling of job insecurity after or in fear of losing tasks to machine learning (AI). Anxiety, skepticism and inefficiency were also seen.

(Wasti, 2003, pp. 315-317) argued that in companies with high engaged commitment, low employee turnover and sick absence levels are seen and higher achievements than in companies with low engaged commitment.

SINTEF: Involvement was raised as a possible buffer to negative reactions to change, as well as information about how the technology will be useful. Interestingly, their projects had as of yet not led to full automatization of jobs. That is, even though job insecurity was something their teams continuously considered, especially the implications for younger generations in rural areas, they had not seen this as a consequence yet.

Learning capacity

The Equinor interviewees found the multitude of digital tools that were expected to be used concurrently especially taxing on the individual, and the split-attention situation related to this, as described in Chapter 4, increased the perceived workload and stress levels. Added to this, the constant rollout of new, lesser developed tools or apps without sufficient time to learn them was described as aggravating factors.

As mentioned, (Kalyuga & Liu, 2015, p. 3) argue that split attention situations may be reduced by "physically integrating the related sources of information (or synchronizing them in time)" in order to reduce the cognitive load in high-tech learning environments. This is in line with the findings from both focus group interviews: whereas the Equinor interviewees suggested a **virtual task analysis**, the Kongsberg interviewees discussed an **AI based template adapted with dynamic input** from the end-users. Such initiatives would aid in mapping risks of such split attention situations and provide an overview of the total cognitive workload.

In parallel with learning capacity, the need for different types of competencies was raised by both groups of interviewees. One of these was **when to trust technology and when to override it.** (Seong & Bisantz, 2008, pp. 611-621) found that "transparency reflects the level to which the underlying operating rules and inner logics of the technology is apparent to the users and is considered to be critical for developing trust in new technology". They argued that it is more problematic for AI than other technologies, especially when methods such as deep learning are involved. An important aspect of transparency includes different types of explanations regarding how AI works or why a specific decision was made that are understandable to users, even when they have little technical knowledge. This was indeed raised by both the focus group interview interviewees in unison.

As **individually adapted learning and learning capacity** were discussed (Equinor interview), the **generation gap** was also addressed. (Coutu, 2000, pp. 37-42) addressed how implementing reverse-mentoring programs may disseminate knowledge across organizations. Nonetheless, the author uncovered the problem of potential generational conflicts, whereby newer generations, who tend to be more knowledgeable and skilled in digital technologies, may gain informational power over others, generating concern and skepticism in older, change averse, individuals.

On an organizational level, (Cortellazzo, Bruni, & Zampieri, 2019) conclude that information technology and strategic management need greater alignment. They argue that digital transformation is successful in the long term when the overall organizational objectives match the need to adopt new digital tools or instruments. Similarly, they claim that individuals embrace technological advancement only when they perceive it is relevant to their tasks. The responsibility to align strategy and promote a digital culture,

they argue, lies with the leaders and especially the C-level leaders and thus they need to develop a combination of digital and human skills to "**communicate** effectively in a digitalized context, create cohesion between geographically distant followers, foster initiative and change attitudes, and deal with complex and fast problem solving". Both Interviewee groups were aligned on this as well, pointing out the need to see the strategies presented by top management, throughout the organization levels, to understand the bigger picture.

Additionally, **involvement** in communication and developing information for new technology was found important. (Chen, Westman, & Eden, 2009) found higher satisfaction within employees that received "resources workshops" to help them adjust to a new IT system. The ones who didn't receive this, reported lower satisfaction with IT and also showed increased exhaustion levels after the IT system was implemented. Similarly, (Elfering, Dubi, & Semmer, 2010) showed that the introduction of an organizational internet portal was associated with health problems only in employees who were not included in the planning and implementation of it. Kongsberg interviewees also added that implementing changes via informal figures of authority and **early adapters as "beacons"** may ease the transition of the rest of the employees into the changes.

The points raised by both groups under this question were in line with studies on "Technostress inhibitors". They consist of 1) technical support provision, 2) literacy facilitation, and 3) involvement facilitation and were found to be associated with higher job satisfaction, organizational commitment and commitment to continue one's current employment (Ragu-Nathan et al., 2008). "Technostress inhibitors" were associated with psychosocial work environment factors often linked to positive health outcomes (Christensen et al., 2020, p. 21).

SINTEF: Old types of competence, contrary to common beliefs, was still needed especially in industrial workers. Many workers still preferred mechanical tasks instead of remote operations. Competence from the field was seen necessary in addition to data technical knowledge. Training is necessary to better understand what machine learning is and is not.

Settings to lessen the negative reactions and strengthen the health promoting reactions

(Hennington, Janz, & Poston, 2011) reported that incompatibility between information system and the employee's personal values constituted a role conflict which in turn was associated with burnout, i.e. emotional exhaustion, cynicism, and reduced perceived personal accomplishment. (Cascio & Montealegre, 2016) posed that the heavy dependence on ICT may lead to communication problems, such as failing to distribute information to all team members, understand or convey the level of urgency or importance of the information, and interpret silence. Conversely, higher "computer self-efficacy", and perceived control over technology, were associated with less "stress" and work exhaustion (Rajeswari & Anantharaman, 2005). On leading virtual teams, (Jawadi et al., 2013, pp. 199-211) concluded that one of the most important practices highlighted in the literature involves the setting and periodical revision of communication norms within the team. They argued that virtual teams need a clear definition around the use of communication tools in order to avoid ambiguity about teamwork processes, correct exchange of information and regular interaction and feedback amongst others. (Lee et al., 2015, p. 1)'s qualitative study highlights "opportunities and challenges in designing human-centered algorithmic work assignment, information, and evaluation and the importance of supporting social sensemaking around the algorithmic system".

Lack of information about why the system is implemented, a minimum of how it works and when the employee may have the support to override it may represent such incompatibility between information system and the employee's personal values (role conflicts) as described above. More information and more clear information may counteract the communications problems attached to heavy dependence on ICT solution. This should be periodically repeated, tested and revised with the teams. Such information, involvement in development of it and support from management to make such overriding decisions, when necessary, may lessen the adverse effects from such role conflicts. Similarly, an individually adapted training, both from simulators and physical environments, may provide such perceived control over technology and counteract some of the stress effects. In sum, all these factors could help in the social sensemaking around the algorithmic solution and contribute to a more human centric design and work organization.

Unsurprisingly, both the Equinor and Kongsberg interviewees raised concerns and suggestions regarding **communication why** the machine learning (AI) is implemented,

that the top management clearly shows **how** it ties in with the companies' overall strategies and that **involvement** is important both in early planning, implementation and in communication. Adopting **human assistive machine learning (AI)** as opposed to replacing humans was recommended to maximize the strengths of both humans and machine learning (AI) and to reduce job insecurity in humans. To contribute to the latter, **communication about the reduction of risk of errors and responsibility with the use of machine learning (AI)** was mentioned**. Adequate training, reskilling** and measures as new competence development in advance was seen as crucial to reduce job insecurity and skepticism to change.

(Schwarzmüller et al., 2018, p. 116) studied how the digital transformation affects organizations with key themes of change in work design and leadership. They concluded that relationship-oriented leadership will have increased importance to meet the challenges of digital transformation in current times such as higher job demands, competency requirements and more challenging work life dynamics. Further, they argued that leaders provide employees with more influence and at the same time focus strongly on achieved results and that is why high relationship-orientation on part of leaders is important to support employees. They suggested coaching and enabling behavior by the leaders in addition to individualized leading, networking and teambuilding especially as the teams become increasingly virtual, agile and work across continents and time zones.

(Demir, McNeese, & Cooke, 2017, p. 11) studied team situation awareness in human autonomy teaming. One of their conclusions was that effective team communication is crucial for both effective Team Situation Awareness (TSA) and team performance. They found that good teamwork includes anticipating the needs of teammates and that means pushing information before it is requested. They concluded that the synthetic teams (human and autonomous agent paring) had "lower levels of pushing information indicating an inadequate ability to anticipate teammate needs, as opposed to members of the all-human teams— and the experimenter condition in particular". Interestingly, "the lower levels of pushing exhibited by the synthetic teams were not compensated by increased pulling or requesting of information. Therefore, the synthetic teams were sharing less information overall, which may explain a lack of TSA and lower performance when compared to all human teams".

Both groups of interviewees discussed the need for a **total workload analysis**, although they named them differently (Equinor interviewees called it a “virtual task analysis” and Kongsberg interviewees called it a “holistic view of total workload”). Interestingly, the latter recommended using machine learning (AI) for planning of workload but pointed out the necessity to do so with input from the users to protect them against many parallel tasks. A somewhat surprising finding from Equinor was the intense switching between very high and very low workloads- they called it **high fluctuations in workload** and advised to avoid this combination as it caused higher stress levels in both situations. In regard to the autonomy and tempo, the interviewees from both group raised the importance of **allowing autonomy and human control in planning task sequence** so that it could be individually adapted. The Equinor interviewees added the importance to have the **authority and support to override machine learning (AI) if necessary**.

The Equinor interviewees added another dimension to the competence, specifying the need for **information on the "black box decisions"** to understand the bigger picture, regularly updated **experience from physical working environment and simulator training**, and a crucial finding was the need for **competence on when to trust and when to override machine learning (AI).**

The Kongsberg interviewees added that regular follow up during implementation and utilization is necessary to mitigate risks and that **resource allocation** could be automised to be more in alignment with the rest of automation processes. Additionally, they found it important that **machine learning is adjusted to and with the human capacities and that training and reskilling is crucial**. Allowing for **more time in the start of projects and implementation of machine learning (AI)** as opposed to the end of them, was recommended to accommodate the **individual needs for learning** and competence acquisition. Another interesting finding from this group was the recommendation that the **task planner should have a relation to the task being planned**, and if they didn’t, user involvement was seen as crucial during planning. The Equinor interviewees added that **split attention situations** should be evaluated and reduced as they caused a strain on the learning capacity.

A topic raised by the Kongsberg interviewees was to share the company’s profits with the persons losing their jobs. The **ethical implications of job losses** due to machine

learning (AI) being raised from employees and management within companies may be a topic management and HR should look into as part of **reputational risk** as it may influence job recruitment within the younger generations who are typically known to value more sustainability, meaningfulness and ethical values when applying for jobs.

SINTEF: Involvement was seen as important. For any settings for improvement within worker led autonomy and tempo regulation the initiative would have to come from the employers (companies) from the outset of the project. Algorithms as anomaly detection could replace potentially dangerous and boring tasks with more meaningful tasks.

5.1 Perspectives in retrospect

Figures 8-12 (appendix 3) depict the expected findings, namely within the theoretical main perspectives and the 6 underlying areas (Figure 6). The findings from the three interviews are shown as a summary of keywords in table 2. The researcher expected most of the findings within autonomy, tempo regulation, role conflicts or personal conflicts, emotional and psychosocial reactions as well as learning capacity. Unsurprisingly, the data from Kongsberg pointed to the same main factors as the one from Equinor.

The factors of total workload analysis including the need for reskilling or continuous training as well as split attention situations were especially gratifying to find as both can be hard to pinpoint. Perhaps it was the researchers bias that played in here, thinking that the effects of digitalization may not be clear to the end users yet, due to the entanglement and multitude of parallel digital processes that may coexist in a workplace in any given time. Yet, it would be the end users, which may be employees *and* managers, that would notice the strain by both factors first.

Interviewees from both Equinor and Kongsberg mentioned in different ways how machine learning (AI) may paradoxically provide a sense of job mastery despite creating job insecurity due to fear of job loss or loss of tasks to automation. By taking some of the responsibility off workers' shoulders, either by reducing risk of errors or reducing the scale or impact of errors, both the groups argued that this may give a sense of support or job mastery. This was confirmed by the interview from SINTEF and exemplified with for example decision support and how anomaly detection algorithms may remove the repetitive and time-consuming tasks while allowing humans competence to be redirected to more value creating and meaningful tasks.

(Conde Vieitez, De La Torre Carcia, & Vega Rodriguez, 2001, p. 216) found that "..the extent to which employees perceived advanced manufacturing technology as a cause of increased unemployment and job insecurity was associated with impaired well-being in terms of symptoms of anxiety and depression, but not with general worries." Likewise, (Patel, Devaraj, Hicks, & Wornell, 2018, p. 1) observed higher levels of job insecurity, and in turn poorer physical and psychological health, among occupational classes at higher risk of automation of jobs. Job insecurity is an important dimension, and symptoms as these may become a prelude to sickness absence if adequate support, information, and training is not provided, as the interviewees in all three interviews mentioned.

(Davenport & Short, 1990) argued that past research demonstrates that the adjustment of employees to new technologies is a key factor in translating technological advances into business revenue and that AI is unlikely to be different. They concluded that organizational leaders, who will manage not only human employees, but also complex systems of different algorithms collaborating among themselves and with humans would be wise to keep the "human in the loop". They saw this as an essential part of AI integration. Further, (Moore, 2019, p. 15) recommends focusing on implementing assistive and collaborative AI rather than heading for the general and widespread competences of universal AI.

The most surprising findings were perhaps the extreme fluctuations between workloads, total workload analysis or cumulative workload, and split attention situations mentioned in the focus group interview from Equinor. Surprising, but not unexpected. Surprising because both are avoidable by a virtual task analysis, and yet not unexpected, as the in-depth interview from SINTEF showed: to mitigate risks like these, the customers (employers) need to instruct the developers to consider and add factors like these in the algorithms they develop. And to do so, they need the OSH knowledge this study points to. These findings are supported by (Glikson & Woolley, 2020, p. 60) who concluded in their review article of human trust in artificial intelligence that a human-centered approach needs to consider AI integration from the employees' perspective, taking into consideration elements that facilitate human trust, and the meaningfulness and importance of a specific task to the employees.

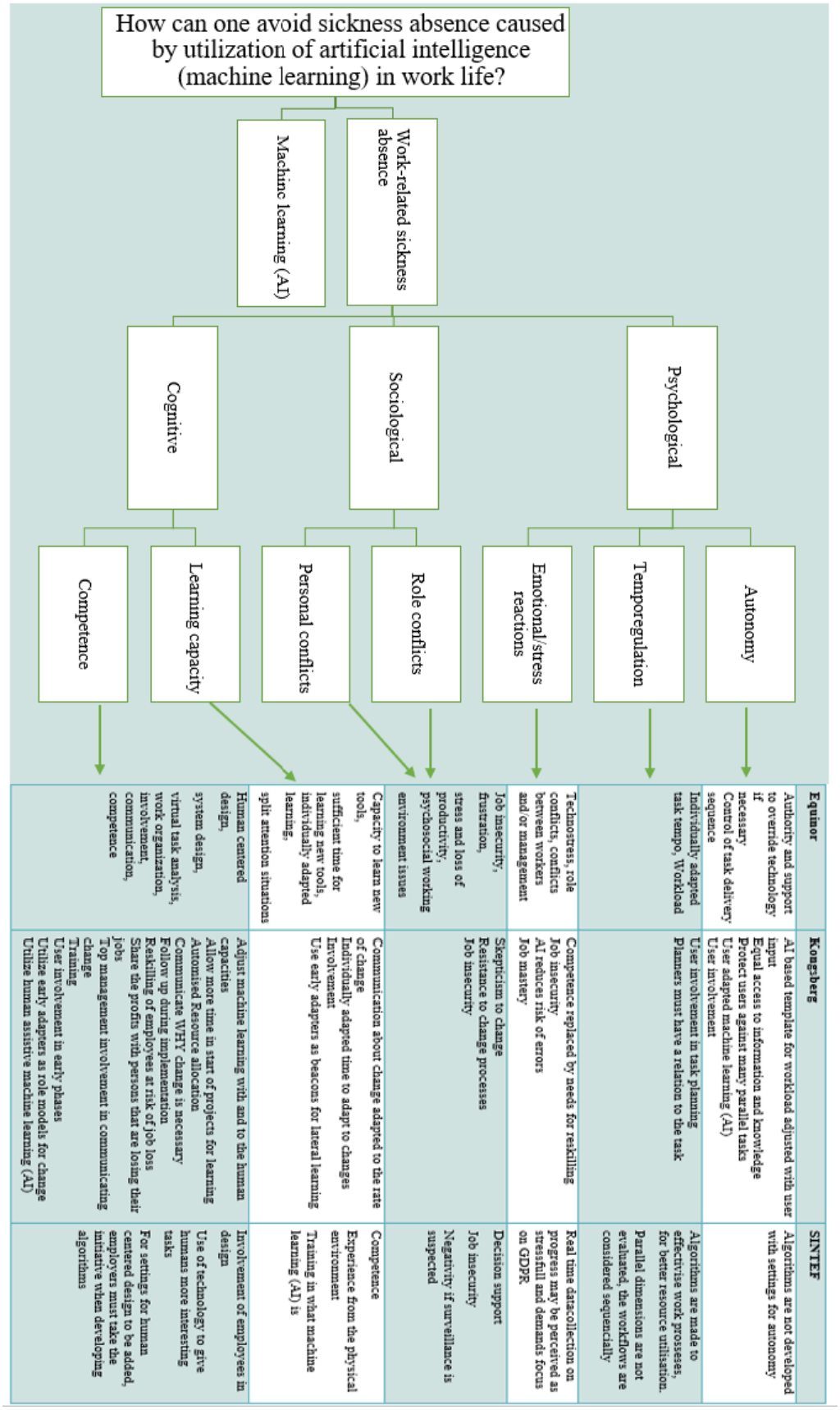

Figure 13 Research question, main theoretical perspectives, a priori themes for interview questions and findings from the three interviews

5.2 Implications

The Norwegian working environment act does not contain a requirement of a specific job description. From the outset, it was based on more physical and technical work environments and only in the past few years the demands to the psychosocial work environment have been specified further. This represents an opportunity to the employers in terms of flexibility in allocating tasks to the employees, but incidentally also a challenge due to the act's requirement to «Secure a working environment that provides a basis for a healthy and meaningful working situation, that affords full safety from harmful physical and mental influences and that has a standard of welfare at all times consistent with the level of technological and social development of society».

The duty of care requires to proactively work in a risk-based manner to prevent consequences as sickness absence and work-related illness. Due to the increasing pace and rate of change, job design has to become more dynamic and sickness absence statistics more proactively geared toward preventing work related illness for the business needs to be met. On a group level, end points could be decreased employee retention rate as well as challenges in recruitment.

On the other hand, in non-technical positions and knowledge workers, there is a gap in framework for what is expected tasks to be performed in a typical position. The companies' need for continuous organizational changes as well as due to digitalization, makes it challenging for the employers and employees to set a standard to compare a change in workload to.

As both interviewee groups in this thesis suggested, a holistic approach to a total workload assessment, in the form of a **virtual task analysis** will be crucial in the way forward to prevent outcomes as described above. Important factors to consider in workload assessments would be **tasks with split attention, totality of the digital tools necessary in the position and the need for constant reskilling and training**. An important aid in this is **human centered design** which would aid in preventing both injury, illness and loss of productivity. This is in line with (Badri et al., 2018, p. 49) who argue that "future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools. In other words, there is a need to clarify why, when, and how technologies influence work and employees.»

(Parker & Grote, 2019, pp. 1-11) propose a central role for work design in understanding the effects of digital technologies and suggest four intervention strategies : 1) work design choices need to be proactively considered during technology implementation, consistent with the sociotechnical systems principle of joint optimization 2) human-centered design principles should be explicitly considered in the design and procurement of new technologies 3) organizationally oriented intervention strategies need to be supported by macro-level policies 4) there is a need to go beyond a focus on upskilling employees to help them adapt to technology change, to also focus on training employees, as well as other stakeholders, in work design and related topics.

The findings in this thesis support the research implying a **need for a common OSH language** based on a multi-disciplinary approach and to follow advice from (Felknor et al., 2020, p. 11), the **OSH services will have to work more cross disciplinary again as a start and Human Factors may be a start at that one common language.**

The experience transfer from the Nordic labor inspectorates (mentioned in Preface) recommends considering virtual tasks in safety delegate rounds and OSH advice.

Additionally, it implicates a new approach from HR (human resources) as well since such virtual task analyses would need to be a collaboration between HR and OSH. The Finnish Institute of Occupational Health (FIOH) is already recommending aiding leaders with creating checklists of requirements to fulfill some of these OSH recommendations as the context and processes are increasingly complicated to understand even for OSH personnel, in addition to the rate of change rising continuously. This also implies a need to reskill leaders, HR, and safety delegates to include OSH competence within digitalization.

It would also require increased transparency about some of the “black box” decisions and people analytics data and more involvement from all parties and employees. Concurrently, the existing and rising concerns related to surveillance and personal data protection would need to be addressed and the processes monitored closely.

Finally, the work environment act itself may need clarification and concretization addressing the abovementioned needs. Should increasing surveillance, black box decisions and a harrowing pace of change in addition to decreased autonomy and involvement continue without a risk-based preventative OSH approach, the threats mentioned by OSHA-EU (Chapter 1) would affect the Nordic and Norwegian context as well. As mentioned before, the Norwegian work life is unique in the sense that

employees offer a higher productivity due to a higher degree of autonomy and involvement. Should an effect of machine learning (AI) be decreased autonomy and involvement, health promotion as required by the work environment act itself as well as meaning of work may be threatened.

Another recommendation is **strengthening the tripartite dialogue** «to find ways and means to reach out to employees and workers in the digital world and new forms of work.» As OSHA-EU pose (Chapter 1), digitalization in the forms of people analytics for example gives new opportunities for a risk-based approach to surveillance of psychosocial and physical work environment but this potential can only be harnessed if there is a collaboration between OSH, HR and the employee representatives as safety delegates. Such a collaboration is mandated by the Norwegian work environment act, but in a digitalization and especially machine learning (AI) context, would require all three parties to change the way they work. **Increasing the tripartite competence** about the work environment and individual health effects related to the introduction and implementation of machine learning (AI) would be crucial. Another implication would be the need to **multi-skill OSH, HR and safety delegates** in terms of these competences. It would also require a **new approach to continuous improvement and internal control processes in workplaces**.

As the management perspective will entail work performance, autonomy, well-being and productivity amongst others, the OSH focus will be occupational health and work environment perspectives on work with machine learning (AI). Figure 14 enlists these suggestions as the basis for a new industry standard. Both will have implications for cooperation with the safety delegates in the tripartite dialogue as listed. For an industry standard like this to be fully effective, both perspectives (OSH and management) need to be effectuated and integrated in the company's work processes in a risk-based manner. Should management fail to follow up, the result may be adverse effects on work environment, employees' occupational health and well-being and ultimately increased sickness absence as well as employee turnover. Should the OSH services fail to follow up on their end, the result will be their being approached in a reactionary and not a proactive, risk based and preventive manner- contrary to the OSH mandate by the work environment act and tripartite dialogue.

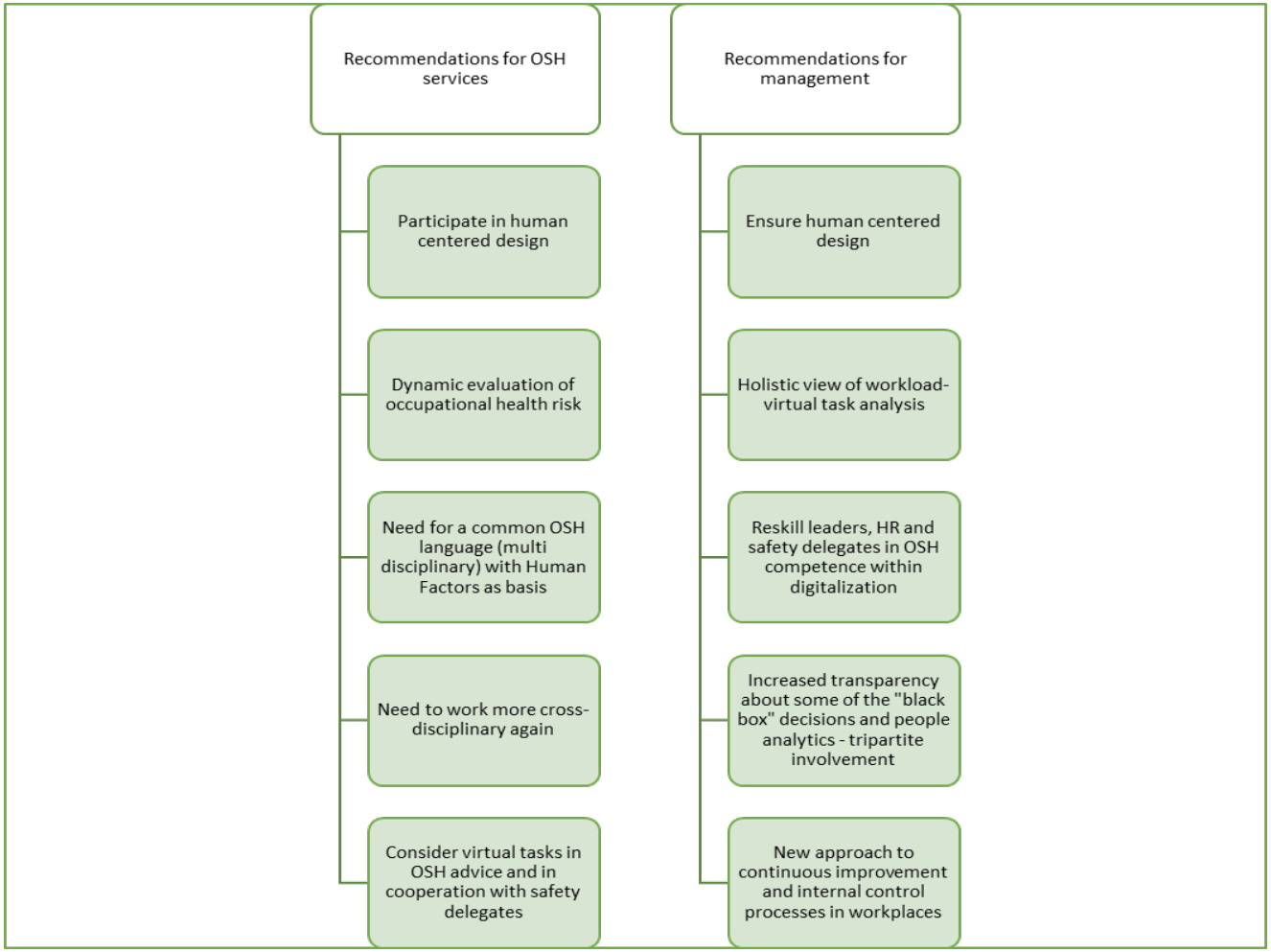

Figure 14 Suggestion for a new industry standard. If sickness absence related to machine learning (AI) is to be prevented, the decision makers will need to acquire related OSH competence, perform dynamic virtual task analyses and from the outset integrate OSH measures. in early phase developments of machine learning (AI).

6 Conclusion

This is an era of rapid digital transformation, where machine intelligence (AI) introduction and implementation is expected to increase exponentially. This thesis set out to develop a state-of-the-art industry standard with concrete advice for management and OSH services so that a safe work environment may still be offered to employees.

The Norwegian work environment act aims to: «Secure a working environment that provides a basis for a healthy and meaningful working situation, that affords full safety from harmful physical and mental influences and that has a standard of welfare at all times consistent with the level of technological and social development of society».

The keywords are «at all times consistent with the level of technological and social development of society." To fulfill these goals, this thesis concludes with the advice that human centered design and virtual task analysis will have to be prioritized on the individual level. On an organizational level, OSH services will have to work multi-disciplinary again with one common language, focusing on Human Factors.. In addition to OSH services, HR, management, safety delegates as well as employees will need increase their knowledge of the consequences of machine learning (AI) on work, work environment and health effects.

In this, lies an opportunity of improving workflows, designing and maintaining safer work environments and employee wellbeing. Should we fail at managing the risks related to the introduction and implementation of machine learning (AI), an increase of sickness absence, work related illness and unsafe work environments will be the cost.

(Glikson & Woolley, 2020, p. 60) conclude in their review article of human trust in artificial intelligence that "A human-centered approach needs to consider AI integration from the employees' perspective, taking into consideration elements that facilitate human trust, and the meaningfulness and importance of a specific task to the employees. Cooperating with machine learning (AI) designers and developers in early phase developments will be crucial to address safety and health risks".

Additionally, communicating why machine learning (AI) is implemented, involving employees in early planning and development of the algorithms, adopting human assistive (AI) as opposed to replacing humans, adequate time for training and reskilling and last but not least, reducing the amount of split attention situations will all be

important. Virtual task analysis will be necessary to properly risk assess the total, individual workload and avoid detrimental effects to the psychosocial work environment.

If sickness absence related to machine learning (AI) is to be prevented, the decision makers will need to acquire related OSH competence, perform dynamic virtual task analyses and from the outset integrate OSH measures in early phase developments of machine learning (AI) by utilizing human centered design. The OSH services will need to work more cross-disciplinary again, develop one common language based on Human Factors and perform dynamic evaluations of occupational health risk. The tripartite dialogue with the safety delegates will need to be strengthened with the same competence.

6.1 Evaluation of research question

The main research question was: How can one avoid sickness absence caused by utilization of machine learning (artificial intelligence) in work life?

From the psychological, sociological and cognitive main theoretical perspectives, five areas of concern were chosen in addition to one area called settings for improvement. These areas were: Autonomy, tempo regulation, emotional/stress reactions, role conflicts/personal conflicts, learning capacity, and settings for improvement.

Meanwhile, a literature review showed gaps as:

a) OSH employees, employers and employees should increase their understanding of the employees' health, safety and wellbeing applications of AI.

b) Future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools.

c) A greater ability to identify problems and more skills within problem solving in OSH that are cross disciplinary and that can predict new risks in OSH.

This thesis' objective was to analyze field experience and compare it to the theoretical main perspectives and the white spots from the literature review. This was done in order to learn from the experiences thus far and adapt the advice from research, labor inspectorates and national and European safety and occupational health services with this experience transfer.

Focus group interviews were conducted in two large, data driven companies in Norway- one from the vendor and the other from buyer of technological solutions perspective. This was triangulated against an in-depth interview from SINTEF- one of Europe's largest research institutes and developers of algorithms.

The findings from this study confirm to a large degree the white spots from research within the areas of concern and also the chosen theoretical main perspectives. Autonomy, tempo regulation, emotional/stress reactions, role conflicts/personal conflicts, learning capacity - the findings in this thesis point to involvement, communication, human centered design and virtual task analysis as being vital to all these points. To prevent sickness absence related to machine learning (AI), in addition to the latter points, raising awareness and competence about its effects on health and work environment will be vital.

6.2 Compliance with earlier research

The experience-based findings of this study are, unsurprisingly, consistent with earlier research as described in Chapter 2 and 5.

One finding not found in the literature review, is the described increase in workload due to parallel, companywide digital initiatives necessitating a concerning amount of multitasking and increasing the split attention situations. The researcher attended a NIVA course called Transformation of work in the digital era as this part of the thesis was written, and representatives from the Nordic labor inspectorates and many large European companies described the same picture and recommended checklists for managers and virtual task analysis to try to disentangle the effects of digitalization. In addition, FIOH (Finnish institute of occupational health) recommended safety delegate rounds and workshops with teams and departments considering interruptions from various communications channels and cognitive ergonomics that included mapping of visual, auditory, cognitive and ergonomic disturbances.

In a similar vein, exposure to beta versions of a multitude of applications and digital tools adds to this workload. A virtual task analysis would have to consider these dimensions and would necessitate an integrated, multi-disciplinary OSH involvement at the C-suite level to fully understand the simultaneous companywide initiatives and processes that contribute to this workload. The extreme fluctuations in workload in some situations, as described by the interviewees from Equinor, is another finding not

found in the literature and should be another aspect a possible virtual task analysis should consider.

6.3 Limitations and opportunities

The initial two companies approached, Equinor and Kongsberg, resulted in two focus group interviews with a smaller sample size than desired (four and three interviewees, respectively). Trustworthiness was increased by having an additional interview with a highly relevant source from SINTEF. To increase transferability even further, another attempt was made after these three interviews, where representatives for over ten large companies, public and private, were approached for additional focus group interviews. Employees from most of these showed initial interest in participating, but despite being informed of NSD approval and guaranteed anonymity, they chose to ask their management for approval before participating. None of them received approval.

There may be many reasons for this obstacle. For example, technological progress is seen largely as a benefit and awareness around its effects as an occupational health exposure is lacking. This is in support of one of the gaps from the literature search. The researcher's role as an employee in another large company may be an obstacle to some that may have not shown interest at all.

When it comes to opportunities from this thesis, the greatest and most crucial of them would be to use the interviewees' experience as a guide to understand the research and theory better as well as international OSH guidelines for digitalization. To develop a common OSH language in a multi-disciplinary approach, will help increase awareness about the implications of machine learning (AI) in how we work and how work affects us as individuals and our work environments.

Another, equally important, opportunity would be to conduct virtual task analysis bearing machine learning (AI) in mind. Additionally, to plan tasks and design workplaces with human centered design with involvement from the tripartite dialogue would be of importance.

6.4 From head to tail

This thesis aimed to develop a state-of-the-art industry standard of recommendations for managers and occupational health services to avoid the sickness absence caused by the implementation and use of machine learning (AI). The context was set in the current phase of the digital transformation, where Norway aims to be world leading in AI usage. The main research question asked was: How can we avoid sick absence caused by the utilization of machine learning (artificial intelligence) in work life?

Three theoretical main perspectives were chosen to triangulate the data collection, namely psychological, sociological and the cognitive perspectives. Two major data driven companies were chosen and the data from focus group interviews from these were triangulated against white field areas from review articles (and a workshop summary). This was triangulated against an in-depth interview from a highly relevant interviewee from SINTEF. The findings support the white theoretical spots from research and the chosen theoretical main perspectives.

6.5 Need for new research?

This thesis opens up several questions for further research:

As (Badri et al., 2018, p. 49) suggest that "..future OSH integration initiatives must from the outset combine a virtual task analysis, dynamic evaluation of occupational health risk, cognitive analysis of workload as well as skills management tools…In other words, there is a need to clarify why, when, and how technologies influence work and employees.» This is supported by this thesis, and research into this topic would be highly interesting.

As mentioned earlier, another interesting aspect would as the tasks requiring logical-mathematical and possibly the spacio-visual intelligences are increasingly taken over by machine learning (AI), how will it influence the working environment?

As (OSHA-EU, 2021, p. 2) argue, "AI-based monitoring could support evidence-based prevention, advanced workplace risk assessment and more efficient, risk-based, targeted OSH inspections. Information could be used by organizations to identify OSH issues, including psychosocial risks, and where OSH interventions are required at organizational level." Where this type of monitoring has been effectuated, research into

its aspects as well as effects would be highly valuable to other companies and industries.

(Glikson & Woolley, 2020, p. 59) argue as the level of machine intelligence increases, the contextual and user-centered factors become more important for cognitive trust. They attribute this to the fact that it becomes more difficult to assess AI reliability. They stipulate questions as “How does the implementation of AI-guided hiring and evaluation change the relationships of workers with their jobs? With their co-workers? With their supervisors?” for further research. From an occupational health perspective, it would be interesting to delve into it to see how it affects work environment.

(Schwarzmüller et al., 2018, p. 21) studied how the digital transformation is affecting organizations, and claim “there is an increased importance of relationship-oriented leadership in the current stage of the digital transformations during which employees are subject to higher job demands, higher autonomy, competency requirements, more challenging work-life dynamics, and where managers provide more influence but demand strong results». This study and others like it demand more attention to the importance of leadership style in this phase and warrant more research into it.

Other areas for research could be for example how machine learning (AI) is affecting the roles of OSH, HR, safety delegates and management as well. Black box decisions in another area that should be explored further in regard to the implications to the tripartite dialogue as mandated by the work environment act. Similarly, the need for more problem-solving skills, that are cross disciplinary, in OSH services would be another area of great interest for predicting new risks in OSH and should include OSH competence in the field of Human Factors as well.

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Appendices

Appendix 1: Invitation letter for the focus group interview (including introduction to the interview)

Would you like to participate in the research project?

Managing safely with machine learning (artificial intelligence) – An occupational health perspective

This is a question to you about participating in a research project where the aim is to **complete and concretize research-based recommendations with experience-based knowledge, and thereby develop an industry standard so that the occupational health is not threatened by AI and the digital transformation in progress.** In this information letter, we provide information about the goals for the project and what your participation will entail.

Objective

You are hereby invited to participate in a focus group interview about your experiences with artificial intelligence (AI = machine learning) and its influence on work environment. The interview will be conducted as part of my master's degree thesis in my role as Executive MBA student at UIS and not in my role as leading advisor in HWE Equinor.

Research shows that introduction of artificial intelligence may cause technostress and negative effects as low job satisfaction, burnout and increased prevalence of bullying in addition to insecurity about one's own competence as well as concerns regarding changes in or loss of job tasks to new technological solutions. AI may also contribute positively to work environment by for instance job enrichment, flexibility and autonomy. This depends on the way AI is introduced.

The objective is to complete and concretize research-based recommendations with experience-based knowledge, and thereby develop an industry standard so that occupational health is not threatened by AI and the digital transformation in progress.

The focus group interview will be conducted with 5-8 participants from the company in central positions attached to introduction/implementation of artificial intelligence. The duration is expected to be 1,5 hours in a Teams meeting. The interview is planned to be conducted with notetaking and audio recording which will be secured according to required criteria for such materials. The statements will be anonymized and submitted to the participants prior to publishing.

Who is responsible for the research project?

The University of Stavanger is responsible for the project.

Why are you being asked to participate?

The participants are chosen from central positions in the company.

What does participating mean for you? If you choose to participate, it will mean that you will participate in a Teams based interview that will last approximately 1,5 hours. The discussion around the questions shown underneath will together with the other participants form the basis for an anonymized report for the thesis. Notetaking and voice recording will be conducted during the focus group interview.

The focus group interview will cover the following 6 main questions:

1. How may we ensure that employees have adequate freedom to describe their tempo of work and sequence of task delivery?
2. How may we ensure that the expected tempo of task execution does not represent a health risk?
3. The introduction of machine learning may cause conflicting demands or personal conflicts between colleagues and/or leader- how may we reduce the risk for this in the workday?
4. Employees may have different reactions to change- what type of emotional and stress reactions do you see in employees when machine learning is introduced?
5. What kind of recommendations would you give to improve the employees' capacity to learn in this setting?
6. What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?

Participation is voluntary
Participation in the project is voluntary. Should you choose to participate, you may at any given time withdraw the consent without having to provide any reason. All of your personal information will then be deleted. There will be no negative consequences for you should you not wish to participate or later choose to withdraw.

Your privacy- how we store and use your information

- We will only use the information about you for the purpose we have informed about in this information letter. We handle the information confidentially and in accordance with the data protection regulation.

- I, Rubia Malik, and my mentor, Dr. Oecon Jan Erik Karlsen Professor emeritus, will have access to data. I will replace your name and contact information with a separate name list stored separately from the other data.
- The voice recording will be conducted via Nettskjema (UiO) which is the tool UiS recommends for use in research and in student theses where one collects personal information, for example during interviews. Nettskjema offers a secure collection via voice recordings, amongst other types, in this case via the mobile app Nettskjema-Diktafon. As a backup the interview will be recorded on an encrypted dictaphone, and the recording deleted after transcribing is complete. When published, your statements will be anonymized.

What happens to your information when we complete the research project?

The information will be anonymized when the project is completed/the thesis is approved, which will be in May 2022 according to the plan. Personal data and recordings will be deleted after the completion of the project.

What gives us the right to treat personal information about you?
We treat information about you based on your consent.

On assignment from the University of Stavanger, NSD (Norwegian center of research data AS) has considered the treatment of personal information in this project in accordance with the personal data protection regulation.

Your rights

As long as you may be identified in the data material, you have the right to:

- Have insight into which information about you we are handling, and to have a copy of the information.
- To have information about you that may be wrong or misleading corrected.
- To have personal information about you deleted.
- To send a complaint to the Data inspectorate about the handling of your personal information.

Should you have questions about this project, or wish to know more about or to make use of your rights, you may contact:

- The University of Stavanger, Rubia Malik and mentor Dr. Jan Erik Karlsen
- Data protection officer at UiS: personvernombud@uis.no

Should you have questions about NSDs assessment of the project, you may contact: NSD – Norwegian center of research data AS via email (personverntjenester@nsd.no) or phone: 53 21 15 00.

With kind regards,

Dr.Jan Erik Karlsen (Mentor)

Rubia Malik (EMBA student)

Statement of consent

I have received and understood information about the project:

Managing safely with machine learning (artificial intelligence)– An occupational health perspective and have had the opportunity to ask questions. I hereby consent to:

☐ Participating in focus group interview

I consent to that my information will be handled until the project is completed.

(Signed by project participant, date)

Appendix 2: NSD approval

NSD NORSK SENTER FOR FORSKNINGSDATA

NSD sin vurdering

Prosjekttittel

Masteroppgave Executive MBA Handelshøyskolen UIS

Referansenummer

981721

Registrert

11.10.2021 av Rubia Naz Malik - rn.malik@stud.uis.no

Behandlingsansvarlig institusjon

Universitetet i Stavanger / Handelshøgskolen ved UiS

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)

jan erik karlsen, jan.e.karlsen@uis.no, tlf: 90036671

Type prosjekt

Studentprosjekt, masterstudium

Kontaktinformasjon, student

rubia malik, rn.malik@stud.uis.no, tlf: 41202885

Prosjektperiode

01.11.2021 - 31.05.2022

Status

15.10.2021 - Vurdert

Vurdering (1)

15.10.2021 - Vurdert

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg den 15.10.2021, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

Appendix 3: Figures 8-12 (Findings)

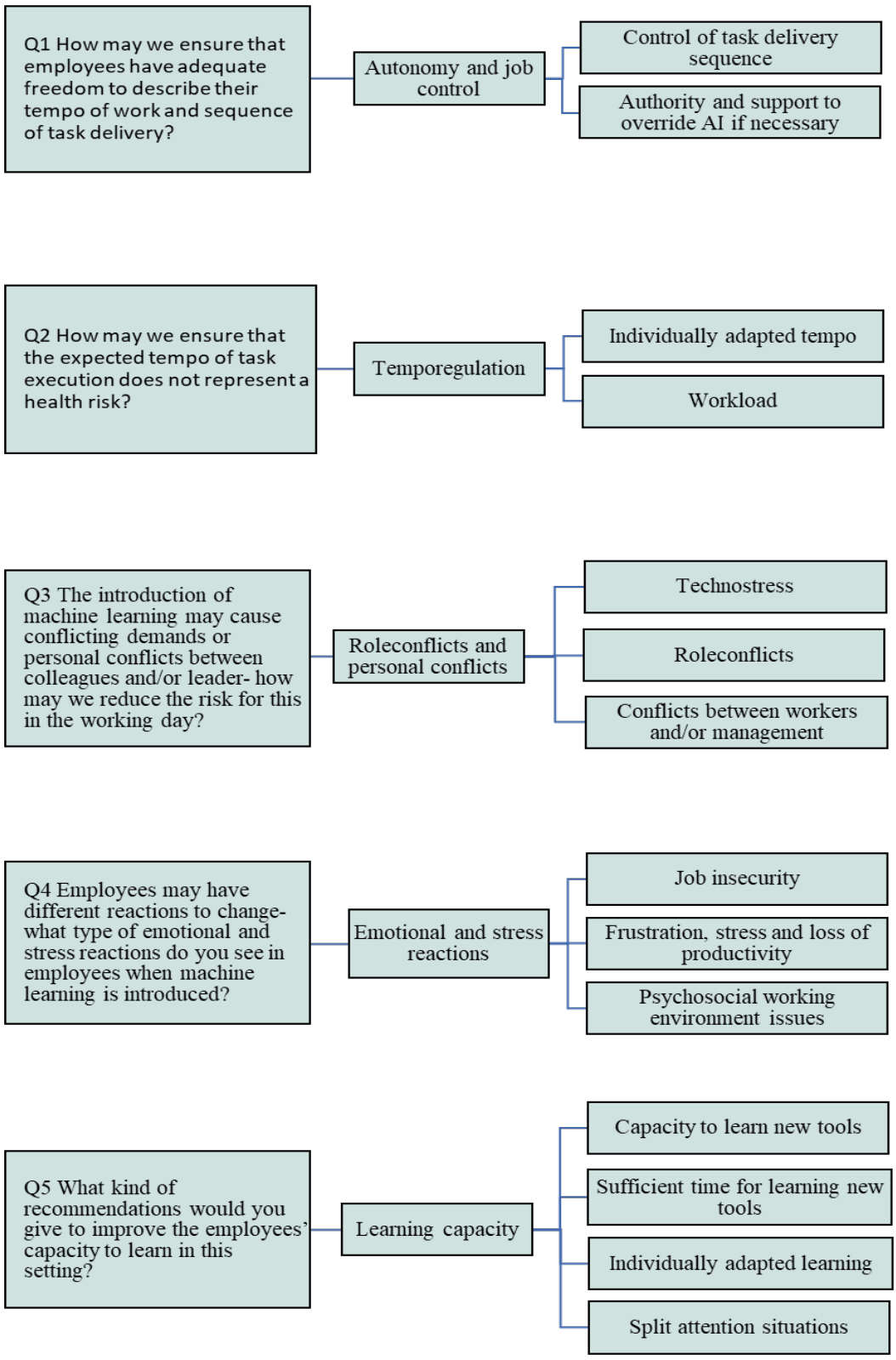

Figure 8 Questions 1-5 from focus group interview Equinor

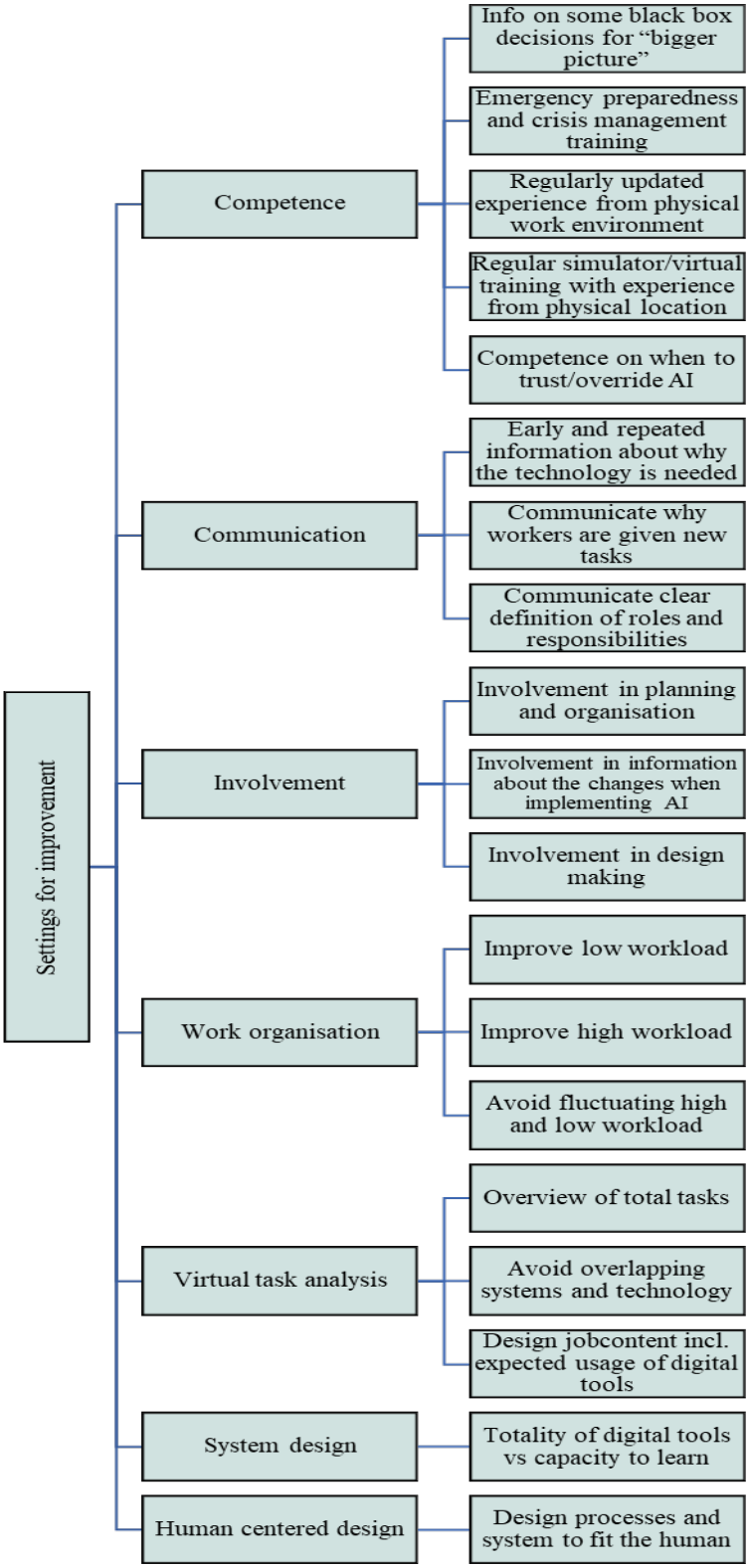

Figure 9 Question 6 from focus group interview from Equinor "What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?**"**

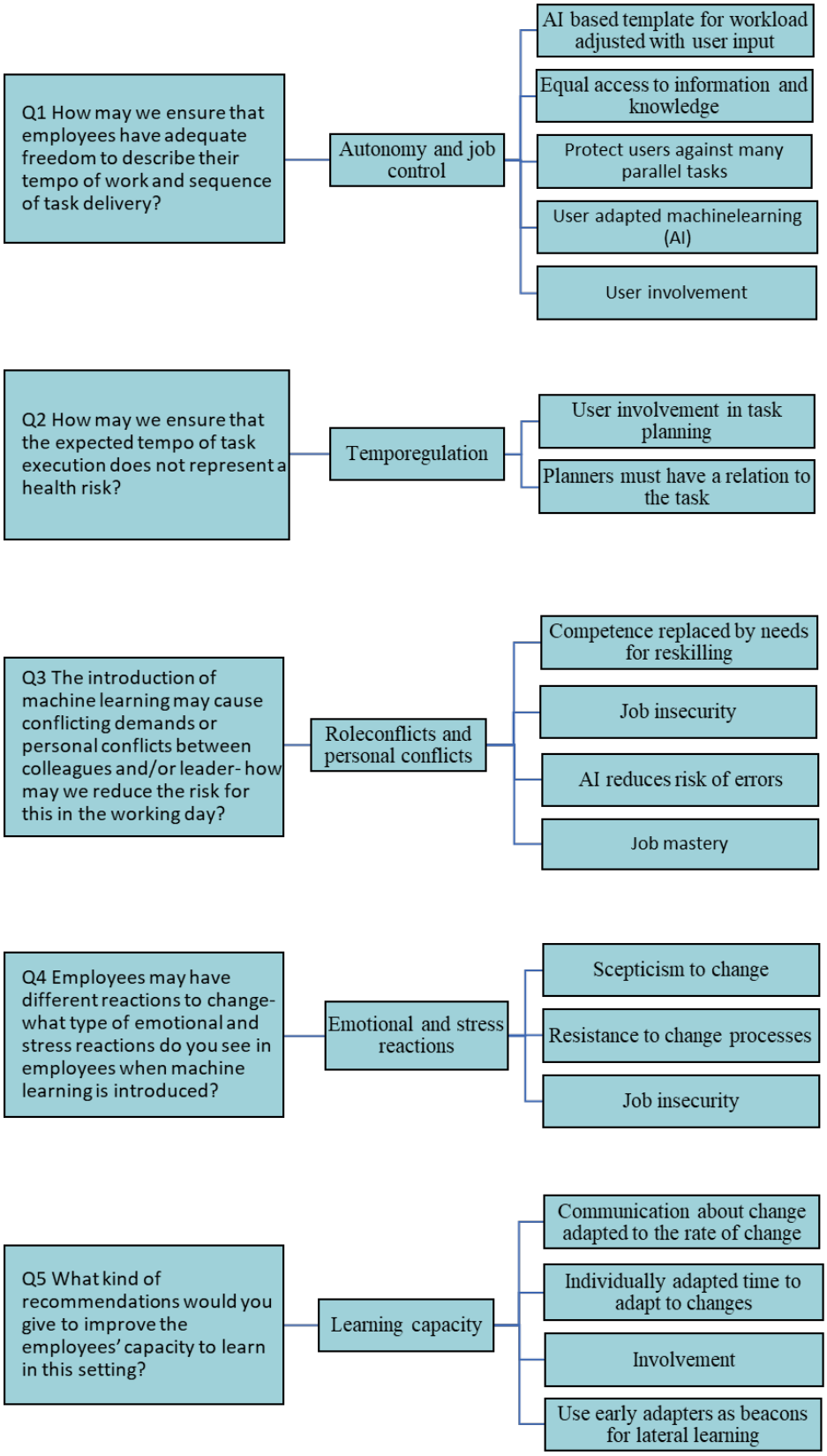

Figure 10 Questions 1-5 from focus group interview from Kongsberg

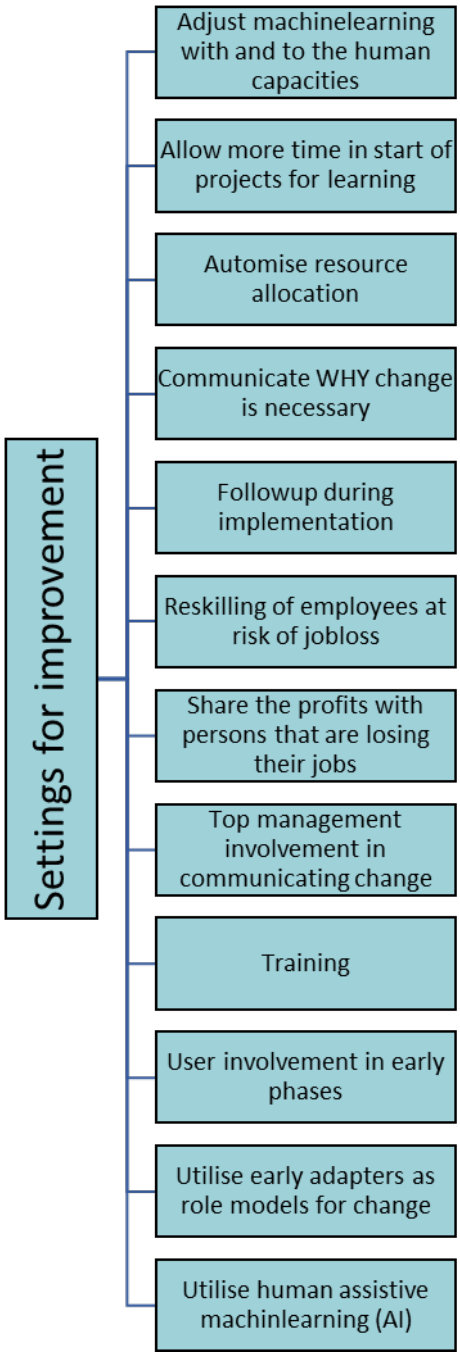

Figure 11 Question 6 from focus group interview from Kongsberg "What type of settings or factors, in light of the previous questions, would you consider changing to lessen the negative reactions, and strengthen the health promoting reactions in employees?**"**

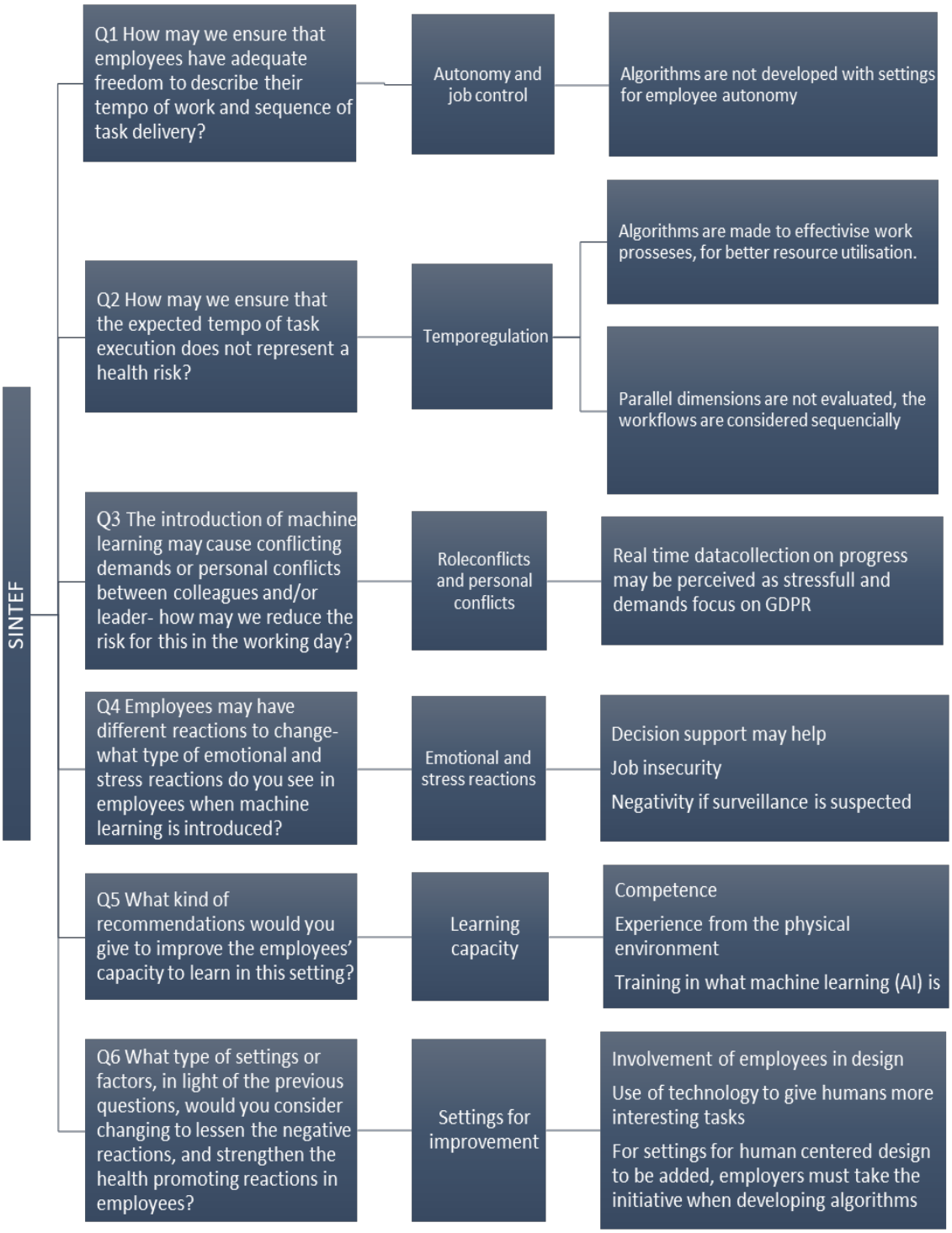

Figure 12 Questions 1-6 from in-depth interview from SINTEF

Appendix 4: Table 3 Summary of statements from the interviews

	Equinor	Kongsberg	SINTEF
Q1 How do we ensure the employees adequate *autonomy* (freedom in task execution) while utilizing artificial intelligence?	*"It is possible to design the systems in such a way that they contain a **sensible task sequence**, and a sensible timeframe for the operators to relate to. That we can design in, we can **design in delays** for example, if we think the operators need longer time, that is one possibility. (Interviewee 3)* *"...so that which **sequences** will come, that you are prepared for what is coming...because it is always stressful when you are not in control, when you don't know what the next step will be..."* (Interviewee 5). *"That is, if an operator is standing in front of a **black box** which telling the operator to not shut down the system and just keep production to normal levels, and the operator thinks* (Interviewee 3 in a hesitating voice) "*I think the black box is wrong, I think I need to shut down". In situations like this, the operator needs to know that someone's got his back. He needs to*	*"I was thinking that perhaps we must use machine learning **(AI) as a template for planning** the various activities. Then we have to adjust it to the employees' needs, because a resource is not a machine (*raises voice in engagement). *Then, I'm thinking both of the **speed one executes the tasks**, the quality one delivers, whether one is experienced or relatively new and if one has many tasks in parallel. Maybe it could be a prize that one also says that this way one may protect the resources against many parallel tasks."* Interviewee 1 *"Access to information and knowledge could also be added here. Let's say I am new, having no network in the company or in the project...then it will be difficult for me to acquire the information or knowledge I need to perform the tasks. As opposed to person X who has been in the company for years and doesn't really need to search for knowledge. This person may contact the right people directly and get answers quickly."* Interviewee 2	*"At least, it would have to come that way. We work mostly with finding bottlenecks in the system, where is the potential to be extracted, to work both more efficiently, reduce idling, that part of it."*

	Equinor	Kongsberg	SINTEF
	know that it is something he can do without fearing negative consequences for himself...And that support needs to come from the management." (Interviewee 3) Keywords: **Authority and support to override tecl necessary** **Control of task delivery sequence**	Keywords: **AI based template for workload adjusted with u input** **Equal access to information and knowledge** **Protect users against many parallel tasks** **User adapted machine learning (AI)** **User involvement**	Keywords: **Algorithms are not developed with settings for autonomy**

	Equinor	**Kongsberg**	**SINTEF**
Q2 What recommendations and guidelines are necessary to avoid that the *tempo regulation* becomes a threat to the health?	*"(It is) important that it is the **human**, that is the one sitting and operating, is in control over work tempo and the sequence of deliveries so that the design ensures that it is not the machines and the system that is steering the employees, but that one manages to design this in a way that the employee is the one in charge, that is crucial."* (Interviewee 5) *"...this is in relation to ... what is expected of one, and what terms exist regarding how fast one should respond or to take action. So, I think one should also see this in relation with the tasks having been **individually adapted**...so that one can keep up."* *"...one thing is having **too much to do**, that may be a stress risk, but it is a point that it may be an equally large risk to have **too little to do**, both in terms of motivation and attention...that is also valid here, I think both sides are relevant as we already discussed...and then the question of how we ensure- that is a good question- that one is in control of the operation...that is at least a pre requisite to be **able to control** (slowly puts emphasis on control) **the tempo**...*(Interviewee 5)	*"One way to do this is that those planning the conditions for a project or an internal work process, have a relation to what the task is. If one does not have that, one must have a dialogue with those who are going to execute the task as Interviewee 2 also mentioned. This is to try to find, to try to understand how long it actually takes. Because if the set time estimate is unrealistic, it will quickly become a health risk."* *"I think one has to take the time to follow up during the process, because unforeseen or unexpected situations will always arise. To be able to help with corrective actions, to avoid health risk or stress from for example working around the clock. Not everyone dares to speak up, in cases like that I would help to make a plan before it becomes a crisis. But I think (giggles a bit) this is a bit hard to think of in terms of AI, that is a challenge. Machine learning (AI) is automation, and we are supposed to automate without too much manual influence or interruption, but I don't think we can avoid manual interruption. The manual interruption might contribute to adjusting the machine learning or a part of it."* Interviewee 1	*"Here, one wished to avoid that (wear and tear of employees due to heavy lifting), and then you would perhaps acquire a different task, maybe following a robot to ensure that it does the job correctly instead of you doing all the lifting yourself."*

	Equinor	**Kongsberg**	**SINTEF**
	"...both learning and training in the tasks is necessary to be prepared, as with crisis management or emergency preparedness training offshore, and have this training as reflexes when needed- this could also help being prepared for a changing tempo and handle this sort of dynamic better..." (Interviewee 5) Keywords: **Individually adapted task tempo**, **Workload**	Keywords: **User involvement in task planning** **Planners must have a relation to the task**	Keywords: **Algorithms are made to make effective work processes, for better resource utilization.** **Parallel dimensions are not evaluated, the workflows are considered sequentially**

	Equinor	**Kongsberg**	**SINTEF**
Q3 Introduction of machine learning may lead to conflicting demands and personal conflicts between colleagues and/or leaders. How can we reduce the risk for this in the workday?	*"…in certain contexts, the introduction of new technology may* ***remove*** *(existing) conflicts and frictions, and contribute to the employees attaining a more meaningful and educational work situation" (Interviewee 3)* *"Sometimes, the introduction of new technology/tools may* ***trigger*** *an already* ***existing*** *conflict, but that has not surfaced yet…Cause and effect are more complicated, I think, than new technology causing conflicts….I know of one workplace in Equinor where the introduction of a digital field worker unit* (app on mobile device) ***generated a lot of noise*** *than other places…When we looked closer, there were other, existing, issues in the psychosocial working environment that were not being managed, and this digital field worker unit was then blamed for everything in working environment committee meetings and so forth…so the way this workplace received this digital field worker unit, reflected somewhat the* ***emotionality that already existed there****.* «Interviewee 3	"…you may have less responsibility then, so you don't have to be afraid of mistaking mistakes, but you now get a support from tools that reduce the consequences of mistakes. Then it will be positive to utilize these." Interviewee 1 "*This is a well-known problem, and it doesn't have to be due to machine learning, it may be a robot or something like it in its simplest form*. Something comes that threatens the job security for a person who may be an employee or a leader. Because the last years we saw that what we perhaps saw, as society, that AI would take over only the "stupid" tasks, may actually take over leader roles as well….Including the persons in how we perform the tasks and in implementation, and show them how this may improve the workload, may help improve their situational awareness and give the persons a sense of security instead of a feeling of being threatened. Involve and include them from the early processes." Interviewee 2	*"You would think that they felt monitored, but I don't think so, they (companies) are very conscious of GDPR (regulations), so it won't happen. But you could imagine that you may receive smiley faces if you drive environmentally friendly, or that you receive suggestions to be careful with accelerating in an uphill because then your CO2 emission is higher than if you drive in a more even tempo. We haven't been involved in it, but I know that the customer is very careful about handling GDPR regulations. Meanwhile, they use the system to receive payment for how many loads the truck has driven, so what they do needs to be logged as well."*

	Equinor	**Kongsberg**	**SINTEF**
	Keywords: **Technostress,** **Role conflicts,** **Conflicts between workers and/or management**	Keywords: **Competence replaced by needs for reskilling** **Job insecurity** **AI reduces risk of errors** **Job mastery**	Keywords: **Real time data collection on progress may be perceived as stressful and demands focus on GDPR**

	Equinor	Kongsberg	SINTEF
Q4 Employees may have different reactions to change. What type of emotional and stress reactions do you see in employees when machine learning is introduced?	*"...what we see often is that employees become **afraid for their tasks and workplace**, and **insecure** of what their place will be going forward, and this may be felt **as stress**." Interviewee 5* *"General insecurity, and the reaction may be to postpone the tasks related to it because one lacks the security for it, one feels one cannot manage it...and I think one may **feel lack of an adequate training** in the new tools which may be many and come with maybe a five-minute online learning...additionally, as mentioned before, having many of these programs to relate to makes it **hard to have a good overview over and leads to stress**."* Interviewee 2 *"**Fear and stress**, obviously. Also, a form of **irritation,** when one has to interact with these tools, chatbots and robots that ask you to speak clearly, and automatized systems that all of a sudden seem like they want to do something else than what you expected...In addition, you in a way acquire almost a new set of "colleagues", that behave differently than what you expect sometimes, and are irritatingly stupid in many*	"If one does not provide adequate training, one will not experience mastery. They (employees) may then give up or try to oppose the new (machine learning) …I think training is the keyword here." "Another thing is to introduce assistants in the form of new (machine learning) tools, that may make the employee better and more effective. More a form of synergy then, and using humans in what they are good at, and machines for what they are good at." Interviewee 3 "Yes, I have seen strong attempts at counteracting machine learning, (digital) assistants, tools, digitalization. Two things are recurring (themes): job insecurity and not feeling mastery because you are used to the tools you already have and new things come and change that….Then next week, newer tools may come, so they (workers) don't care about what you are talking about now. More frequent degree of changes may also contribute to introducing stress. That is something one should admit in large organizations that have a rapid rate of change." Interviewee 2	*"I think, generally speaking, that people are more positive to change if they have been involved in finding out how the system should be made. If you feel that you have been involved in influencing and developing, that these are things that are useful to us and things that are not so (puts emphasis) useful. Then, I think people are generally more satisfied with the change or how it may help you. That, I think, is independent of whether it is machine learning or whatever it may be…" "Yes, that is something we consider in each case. What we are about to start, how will this influence the job security? But so far, we haven't had any cases where we've*

	Equinor	**Kongsberg**	**SINTEF**
	*contexts….sometimes, the developers of the tools use their customers as beta testers of immature apps and only correct each version after receiving complaints, so you expose the end users to **unnecessary frustration and stress**."* Interviewee 3 Key words: **Job insecurity,** **Frustration, stress and loss of productivity, Psychosocial working environment issues**	Key words: **Skepticism to change** **Resistance to change processes** **Job insecurity**	*automatized away from people."* Keywords: **Decision support** **Job insecurity** **Negativity if surveillance is suspected**

	Equinor	**Kongsberg**	**SINTEF**
Q5 What type of recommendations would you give to improve employees' capacity to learn in this setting?	*"But, if I may say, in general the problem is, perhaps not specifically for machine learning but pertaining the way we introduce (digital) tools in the organization, that they may or may not receive training in, that they have to learn to use- but use seldomly. Because there are too many tools for them to be trained well, so I think that we may achieve this for singular tools with good interfaces, but in my opinion, it is the* ***totality*** (emphasizes this slowly) *that is the problem. Our operations groups operate in between 30 to 40 different (digital) tools that they use for production optimalisation and so forth." (Interviewee 3).* *"Two things I think of are adequate* ***time for learning and training on simulators*** *where you may get a feel for the actual results of your work are essential".* Interviewee 5	"*Using some "beacons of change" as role models, some that are positive (emphasizes and raises the voice), to join and advocate the change processes. Then later have gatherings with the rest for experience sharing, showing how one changed the way to work, share with the ones who might be struggling or haven't started yet."* Interviewee 1 *"What comes to mind immediately is that people should get the time they need to learn, or to contribute to change…We must give people time and resources to embrace that change".* Interviewee 2 *"And I think it is important in that type of change processes that we are talking about here, that you manage to communicate a common understanding of why (puts emphasis) you are making the change).* Interviewee 3	*"What we find useful, is to achieve an understanding of what machine learning is and what it is not. Some may believe that an algorithm will come and know everything, what one would call general artificial intelligence, and in that respect there are many disagreements about what is realistic. What we work with mostly is analysis, modulation, and some learning from data of course, machine learning. But to understand what the system is capable of and not, especially, it will take a lot for it to come and overtake everything. To get a better understanding of what it is and what it is not, I think a good training is necessary."*

	Equinor	**Kongsberg**	**SINTEF**
	"...the employees working in central control rooms of remotely operated installations, may have long pauses between performing certain tasks, so what was said about simulator training is crucial. They should be allowed to use the time in between these task to train in simulators. Luckily the company has a lot of good ongoing work on this already." Interviewee 3		

	Equinor	**Kongsberg**	**SINTEF**
	Keywords **Capacity to learn new tools,** **Sufficient time for learning new tools,** **Individually adapted learning,** **Split attention situations**	Keywords: **Communication about change adapted to the rate of change** **Individually adapted time to adapt to changes** **Involvement** **Use early adapters as beacons for lateral learning**	Keywords: **Competence** **Experience from the physical environment** **Training in what machine learning (AI) is**

	Equinor	**Kongsberg**	**SINTEF**
Q6 What type of settings or factors in light of the previous questions would you consider changing to lessen the negative reactions and strengthen the health promoting reactions in employees?	*"The first thing that comes to mind is ensuring that the person partaking in the work process has an adequate understanding of what is going on, why it is happening and the machine learning process…the latter will for many be a black box…so to have a* ***conceptual understanding of how things work*** *will contribute to create an understanding between the colleagues…so that when things change drastically (which happens when more data is collected), if one is not UpToDate on the changes, it may potentially create conflicts among colleagues…As for the employee-manager relation, it is important to give adequate space and* ***trust*** *the operator….It is also crucial that the operator understands the bigger picture, as to what risks lie in for example a control room, what consequences one risks if one does not shut down. Even though one may not understand everything inside the black box, the* ***operator should be able to see this bigger picture****." Interviewee 5*	*"I would give them more time in the start phase. If they get more time to change and learn in in the start phase, it will contribute to the knowledge level and abilities over time and then you may save that time in the end of the project."* Interviewee 2 *"This demands equal work from the leaders as well, for them (employees) to follow and utilize it (tools). Automating the resource booking would be helpful, to avoid that 4 leaders don't allocate the same resource. This way, we could ease the way to find other resources when one more easily can see what resources there are to choose from."* Interviewee 1 *"In my experience, visible top management and informal figures of authority on several levels in the organization may be a positive thing as well. If they can speak and show that the change is positive, ….people may be more receptive of change if top management is visible during implementation."* Interviewee 2	*"..You don't have to spend time on boring tasks as well, for example watching a video of* (undamaged) *roadside traffic barriers…If you instead get a marked off area where you have to examine 10 points on a distance of 10 kilometers for example, then you may spend your time on that instead. That is, you may get more meaningful and value creating tasks that enable you to detect what's right more easily."*

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	*"I was thinking that it is important to **clarify** the work tasks, because they may change going forward, and the distribution of these between disciplines may change as well. So, to avoid conflicts, it is very important to **clarify beforehand**, so one does not end up with conflicts as to who is to perform what…We had a situation on an installation where management, in quiet periods, wanted a shift to perform tasks belonging another shift, but **that*** (raises the voice decisively) *the first shift did not want to do, they wanted to perform tasks that belonged to them. In this situation, it had not been clarified beforehand, and the employees did not **agree** with management on how to do it and they became very **negative.**"* Interviewee 4 *"…and as several of us mentioned, **involvement**, that the tools are not forced upon the workers but instead they should be allowed to participate in deciding how these tools will be used in their workplace…we have many good examples of this from central control room design where operators*		

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	participate in the design group and experience transfer from other projects is utilized. In addition, safety officers and the working environment committee play active parts in this." Interviewee 3 Keywords: **Human centered design, system design, virtual task analysis, work organization, involvement, communication, competence**	Keywords: **Adjust machine learning with and to the human capacities** **Allow more time in start of projects for learning** **Automated Resource allocation** **Communicate WHY change is necessary** **Follow up during implementation** **Reskilling of employees at risk of job loss** **Share the profits with persons that are losing their jobs** **Top management involvement in communicating change** **Training** **User involvement in early phases** **Utilize early adapters as role models for change** **Utilize human assistive machine learning (AI)**	Keywords: **Involvement of employees in design** **Use of technology to give humans more interesting tasks** **For settings for human centered design to be added, employers must take the initiative when developing algorithms**