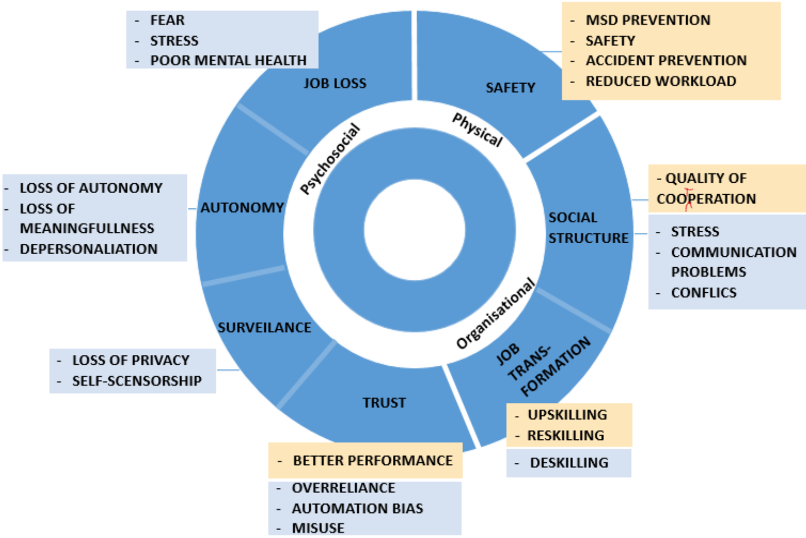
ADVANCED ROBOTICS AND AI-BASED SYSTEMS IN THE WORKPLACE: OSH CHALLENGES AND OPPORTUNITIES ORIGINATING FROM ACTUAL IMPLEMENTATIONS

Figure 1: Overview of OSH-relevant factors and effects based on literature review



New technologies in the workplace create both challenges and opportunities for occupational safety and health (OSH). Advanced robotics and AI-based systems are no exception to that. When consulting current literature on possible OSH effects, one can see a number of recurring factors (Figure 1). They can be classified as physical, psychosocial and organisational OSH factors. Not every technology presents every single one of these elements, and the expression of them also differs on a case-by-case basis. While there is tremendous value in learning from research about potential challenges and opportunities, consulting first-hand experience allows adding nuance to these insights. As part of EU-OSHA's research on advanced robotic and AI-based systems for the automation of tasks and occupational safety and health (OSH), 11 case studies and 5 short case studies were developed that focus on workplaces that use these technologies. The versatility in advanced robotic systems and AI-based systems is one of their most well-known qualities. They can be used in a wide range of workplaces, supporting and automating numerous tasks. Each individual case study can come with challenges and opportunities specific to their scenario, and those need to be addressed on an individual basis. However, there are a number of repeatedly occurring OSH opportunities and challenges when it comes to these technologies.

Opportunities

Physical workload reduction and physical health improvement are the most commonly anticipated and experienced opportunities when it comes to **advanced robotic systems**. This can be achieved by supporting the worker to avoid long-term strain injuries, removing workers from hazardous working environments, reducing their workload or avoiding accidents. These benefits, so far, predominantly occur during the automation of physical tasks through a robotic system. AI-based systems for the automation of cognitive tasks have not been attributed with this effect.

Cognitive (work)load and health, or the improvement of these factors, is another commonly encountered opportunity when it comes to both AI-based systems and advanced robotic systems. The effect can take place over a variety of factors, such as the reduction of input that must be assessed by a worker or an optimised workload in general, as the system prevents unnecessary iterations of the task or the system preselecting which information to display to workers. These are typically found when AI-based systems automate cognitive tasks. However, systems that automate physical tasks have also been attributed to having a positive influence on the cognitive load and wellbeing of workers. When these systems perform their task reliably, they alleviate the worker of having to plan and perform that task and, in some cases, reduces their need to anticipate processes or previously necessary mental energy that went towards mentally monitoring safety during task performance (such as the mental energy a worker might allocate when lifting a heavy workpiece to assess the risk of dropping the piece by accident, which a cobot would not do).

Increased task variety or **reduction of monotony in workplaces** is attributed to most advanced robotics and AI-based systems, based on interviews with the workers impacted. In accordance with most literature, these systems are often used to automate repetitive, monotonous tasks. The worker is then assigned either more interesting or challenging tasks or can allocate more time and resources towards the remaining task or tasks they perform with the system. Some companies have even taken the opportunity to restructure their workflow entirely, simultaneous to implementing new technologies. Specific for robotic systems in the automation of physical tasks is also a shift in job focus. Workers tend to perform fewer physical tasks and more cognitive tasks as a result of automation.

Worker qualifications and their improvement is another frequently named opportunity. Many companies use the introduction of advanced robotics or AI-based systems to expand their workers' skill sets. This is not only to allow them to use the system effectively and efficiently, but also to expand their knowledge to other working areas and equip them with skills that are considered valuable in the future. While there is discussion on the matter of deskilling as a result of automation, companies primarily focus on **upskilling** and **reskilling** their workers.

Job control as an opportunity within task design should be maintained or increased when autonomous systems are introduced to a workplace. This can happen through a variety of avenues. In some cases, the system can be used to prepare material before the worker needs it, creating a buffer of material that the worker can access. More generally, many systems increase workers' time allocation. For example, automated guided vehicles can be used by a worker to receive supplies without having to spend the time to retrieve them themselves. This freed time can be allocated by the worker where they need it at that time.

Wellbeing is often named as an opportunity to address various factors. An increase in wellbeing is attributed to increased ergonomic design within the workplace due to the new technology, the prevention of injuries and the reduction of physical risks during work, and the reduction of monotony, to name a few.

Advanced robotics and AI-based systems also hold the opportunity to support **inclusion at the workplace**. Primarily named in the context of physical task automation, these systems hold the potential to make workplaces more accessible to workers with different needs.

Screen time reduction is one of the opportunities primarily associated with the automation of cognitive tasks. When an AI-based system preselects or presents information the worker needs in a more comprehensive way, it reduces the time they spend looking at a screen. This can not only reduce strain on the workers' eyes but also reduce sitting time.

Social interaction, or its negative expression of social isolation, is one of the more frequently named risks of these technologies in the literature. However, based on the experience of companies using these systems, they have, at worst, had no effect on the social interaction within the company, or a positive one. The situation is described as neutral when the systems support workers in tasks that were previously performed by them alone. Positive effects on social interaction are attributed to workers having more time to interact and help one another as a result of the systems' implementation, or to experience more personal interactions because their job routines changed. Interestingly, there are also cases where the systems have been integrated into the social structure of the company where workers refer to them by name and consider them, in a way, colleagues.

Challenges

An almost universally faced challenge is the **fear of job loss** within the workforce and the consequences this fear leads to. While all companies state that their intention is not to eliminate workers from workplaces but rather to move their workers into more fulfilling positions through training, the fear of losing one's job seems to prevail especially during the initial phase of introduction, despite extensive education and worker training. Perceived job insecurity is related to the risk of depression, anxiety and emotional exhaustion, as well as low general satisfaction with life.[1]

While the above-mentioned process of upskilling and expanding workers' qualifications is an opportunity, the **increased cognitive workloads** that these changes bring can be a challenge. Companies report that workers need to acquire new skills in a short amount of time, while also adjusting their working routine. This can be a change people struggle to adapt to, as well as a challenge for some workers to meet the increased cognitive demand of their job. In addition to that, tasks can become more disjointed, leading to more task switching as there is decreased **task completeness**.

[1] Llosa, J. A., Menéndez-Espina, S., Agulló-Tomás, E., & Rodríguez-Suárez, J. (2018). Job insecurity and mental health: A meta-analytical review of the consequences of precarious work in clinical disorders. *Anales de psicología, 34*(2), 211-223. https://dx.doi.org/10.6018/analesps.34.2.281651

Increased **task consolidation** is another challenge some companies, or specifically their workers, face. They might need to perform not only more disjointed tasks, but these tasks might also have a higher cognitive demand. This leaves workers with possibly less-balanced job demands throughout the day.

Another challenge simply is the **actual physical risks** from working with an autonomous or semi-autonomous system and **residual physical and environmental risks** that remain when working with machinery in general. While all systems undergo risk assessment to ensure they are as safe as possible, there will always be a residual risk of injury from unpredicted malfunctions, misuse or human oversight. It is important that workers are equally aware of this as they are of the safety measures of these systems.

The remaining risk of injury mentioned in the previous section is described as inherent to working with machinery and does not exceed the risk of traditional automation technology. However, there are instances where workers report **fear of the technology**. Workers who reported fear of physical injury from the system did so primarily before or within the initial days of working with the system. This fear decreased as workers experienced themselves that the system is safe to use.

Within the context of fear towards the technology, negative attitude also poses a challenge for OSH. Some workers have a greater **negative attitude** towards technology than others. This does not need to be specific with regard to robotic systems or AI-based systems, however, they generally are included in these attitudes. A negative attitude can have many sources. The above-mentioned fear of job loss, lack of trust or fear of injury can contribute to it. However, as many of these systems are mandatory to use, workers will have to perform their task with a technology they hold negative feelings towards. This can potentially negatively influence their job satisfaction or wellbeing. To change someone’s attitude, the root cause must be identified so that interventions addressing this matter can be planned.

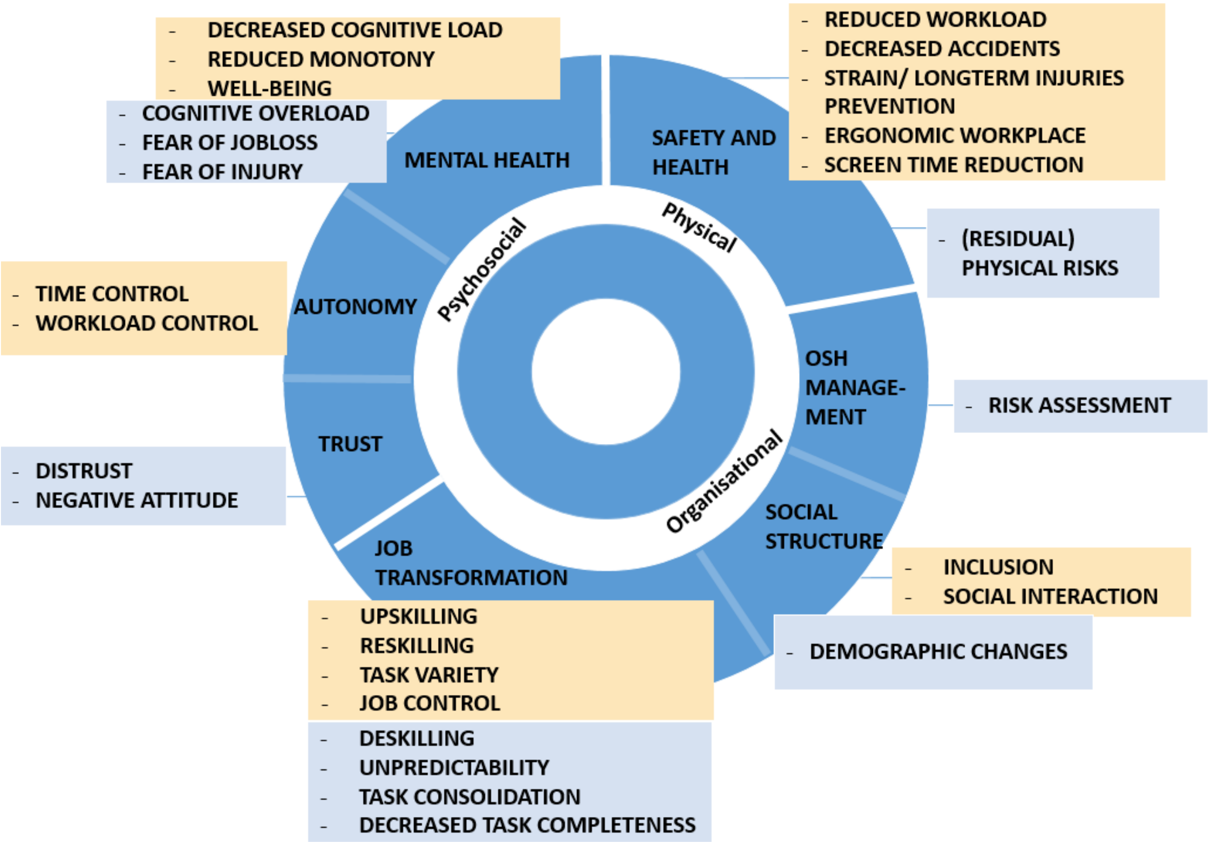
Unpredictability is often associated with self-learning systems. However, companies stress that despite the possibility of introducing a continuously learning system into the workplace remains, this is simply not the current state of procedures. AI-based systems are trained before their implementation on special data sets. Continuous unsupervised learning during everyday work is not common practice. Hence, companies are aware of the possibility, but it typically does not apply.

While upskilling and reskilling are listed as frequent opportunities associated with the introduction of advanced robotics and AI-based systems, the effect of **deskilling** is explicitly named less frequently. However, some companies acknowledge that in the process of automating their workflow, specific skills become redundant and are no longer trained. The decision to stop training these skills is based on an assessment of which skills are seen as important in the future for workers and for the company. Hence, deskilling typically does not occur without re- or upskilling of some form.

Risk assessment in and of itself is one of the greatest tools for OSH. Companies see the potential for the further development of risk assessment tools to match greater system flexibility. Current tools in some cases do not reflect the technology in its current state and abilities. It is important, as technology develops, for the tools used in its context to mirror that development. Companies focus on upskilling their workers, nevertheless there is a reported **need for highly skilled and specialised staff to implement and maintain these systems**. These are often new tasks that require extensive education, which is why upskilling workers into these positions can be difficult or time consuming. While this holds the potential for creating new jobs when not enough qualified personnel are available, this can result in less systems being installed or the overall process taking longer. This comes at the cost of all potential OSH benefits workers would have from these systems.

Also another OSH challenge faced by some of the companies, relevant to that, arises from the **demographic changes** in the workforce that are currently happening. It should be noted that this can differ between sectors. Within the manufacturing sector, skilled and experienced workers are retiring, and companies struggle to find replacements. Companies may try to compensate by increasing their efforts to automate production, which possibly increases the fear of job loss in existing staff.

Figure 2: Overview of OSH-relevant factors and effects based on company experience



Based on the consulted companies, one can see a very diverse set of relevant OSH factors in relation to the implementation of advanced robotics and AI-based systems (Figure 2). These technologies share opportunities and challenges for OSH, but not all will apply to every case study. Furthermore, technology-independent factors like work culture can influence if or how certain opportunities and challenges manifest. For example, a company that already has a focus on using technology to further inclusion might already have structures in place to do so with advanced robotics and AI-based systems. A company's culture towards automation might influence the extent of negative attitudes towards the technology.

While this list is not exhaustive, as these systems can be applied in such a variety of workplaces with unique OSH conditions, it allows an initial overview. This can be an initial starting point for possible research in areas that are currently underrepresented in the literature, as well as guidance for companies that consider implementing these technologies.

Recommendation

The implementation of advanced robotics or AI-based systems comes with challenges, risks and opportunities for OSH. However, companies that have installed these systems at their workplaces seem to agree that the OSH opportunities outweigh the challenges and risks.

An important takeaway is that the combination in which the challenges and risks appear can differ greatly from application to application. A base assumption that all robotic applications and AI-based systems will present common challenges should be observed with nuance. **These technologies share opportunities and challenges for OSH, however, technology-independent factors like work culture can influence their expression.**

Physical, organisational and psychosocial factors are each represented at a comparable level. However, it has to be noted that they should not be compared in quantity. Each factor, when applicable to a case study, **expresses a different quality**. This also explains the presence of opposing factors within the list. Both decreases and increases in cognitive load have been reported. They can even appear in a singular case study, in relation to different facets of the implementation. While the technology itself might reduce cognitive workload, the adjustment to a new routine and training required to use the technology can (temporarily) create cognitive overload. This stresses the importance of **continuous monitoring for OSH challenges and opportunities, and the changes in OSH management to which this leads**.

Interestingly, most of the named OSH factors appear in the context of robotic, non-embodied AI-based and hybrid systems. While there are some that are overrepresented in one type of technology (for example, residual risk of physical injury for robotics), a **considerable amount appear in all contexts**. Organisational factors especially often transcend the technology barrier. This is not to say that different technologies cannot come with unique challenges and opportunities, but rather that these express on a more detailed level (for example, the extent to which task consolidation occurs at a given workplace). Knowing that the general occurrence of many of these factors is shared among different technologies can help companies move on faster from the question if they apply to their case to what expression these factors take in their case.

The most **difficult challenge to overcome for OSH**, based on the actual experiences of the companies, is psychosocial factors like the fear of job loss and a negative attitude towards the systems. Not only can these be accompanied by other phenomena like decreased motivation or job satisfaction, they can also **influence other facets of OSH** as a result. If workers do not use the system correctly because they do not trust it or feel like it is going to make them lose their job, they might reject using it, or misuse it. The former would cost them the OSH benefits the system has to offer; the latter might put them or other operators at risk. Performing risk assessments can help companies anticipate and react to a wide variety of technological OSH challenges and opportunities, however, they typically do not take factors like workers' attitudes into account. Based on the companies that contributed to this project, the most reliable way to anticipate and later address these kinds of challenges is through an **open, continuous dialogue with their workers**, in which their concerns are taken seriously and addressed adequately. How to address the challenges and opportunities this dialogue reveals will have to be dealt with on a case-to-case basis. The presented overview can be used to support this exchange.

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