AI-BASED MATERIAL QUALITY CONTROL MEASURES (ID15)

Introduction

An increasing number of companies employ artificial intelligence (AI) or advanced robotics in their workplaces. 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 objective of a case study is to investigate the practical implementation of advanced robotic and AI-based systems for the automation of physical and cognitive tasks in the workplace. This includes researching their impact on workers and related OSH dimensions, specifically, how OSH is managed in relation to such systems. This will help companies, policymakers and researchers gain a better understanding of the drivers, barriers and success factors for safe and healthy implementation of these systems.

To identify such case studies, several key informants at the EU and international levels, including workers' representatives and industry associations, were consulted. The participating companies then filled out a questionnaire, providing information about their company, describing the technology they use and addressing OSH-relevant topics regarding task automation. These results were then categorised within a taxonomy published in EU-OSHA's report 'Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health'. Finally, each case study presents key takeaways, based on the experience of each company.

General company description

This short case study describes a company that is a system integrator providing custom automation solutions for their clients. Founded in the 2010s, it focuses on paint shop automation specifically, but also provides other automation solutions including AI-based systems. It has multiple locations throughout Sweden and Norway, employing under 50 workers in total.

The company's main objective is to contribute to both **improved profitability** and **increased competitiveness** through their automation solutions. They aim to achieve this goal in a threefold approach. First, they focus on their workers' competence and knowledge, as well as their experiences within the automation industry. Second, they focus on client communication and collaboration, as their product allows optimised process integration if the clients' requirements and circumstances are clear. Lastly, they focus on a strong cooperation with leading robotic developers. This way, their automation solutions can reflect current standards of technology.

The company builds individual automation solutions for their clients, splitting expertise among their locations. The Swedish location focusses on robotic automated surface treatment of, for example, cars. In addition, and as the focus of this short case study, they also create **quality control measures using AI-supported robotic automation**. The Norwegian parent company creates AI for the context of material handling and identification. **The AI helps identify materials and affirms various quality control markers of the product for a client.** This is done through a sensory input, for example, camera-based image analysis. The AI is combined with a **robotic system**, which then selects materials based on the AI's quality assessment.

Description of technology

The company **develops and integrates** both **robotic automation** solutions as well as **AI-based ones**. The Norwegian location specialises in AI-based solutions for different material-based quality control measures. When materials that the machines handle are difficult to identify, **the AI is trained to perform the identification task for the worker**. One application for this **technology is produce sorting machines** that operate on a short time frame to determine the quality of the produce. This formerly entirely human task is supported by a combination of AI and advanced robotics; the AI scanning the product and determining its quality, and a robotic arm sorting them out if they do not meet the necessary criteria. A key factor is that this machine can perform these tasks at a significantly **higher pace** than human workers can. The AI determines whether a product meets all necessary quality criteria through **multiple sensory input**, such as **camera images analysed for shine and coverage in the produce**. The robotic arm then sorts the produce accordingly. To configure such machine learning systems, the algorithm requires input to learn on, however, once the system has been initialised, it can work on a **self-learning basis**. In the case of the robotic system, **sensors monitor whether a human worker is close, and will trigger a safety routine in the form of the machine slowing down or stopping entirely, to create a low-risk environment**. A driving factor behind these systems is that the automated solution performs the task more effectively than a human worker can. Regarding the quality control tasks, the system does not require concentration that is possibly influenced by external factors in a human worker. The robotic paint automation also does not experience tiring or reduced precision over time.

As this short case study describes the perspective of a system developer and integrator, rather than the end user, vital lessons can be learned for their perspective and influence on OSH during the system conception and integration process. As they offer custom solutions to their clients, every system comes with unique challenges. However, a challenge for AI-based systems they have encountered is that, initially, the **machine learning systems require a lot of input to work properly**. Depending on the product it is supposed to categorise, this process becomes more difficult and time-intensive (organic matter is generally harder to classify). However, after the initial learning phase, it works on a self-learning basis.

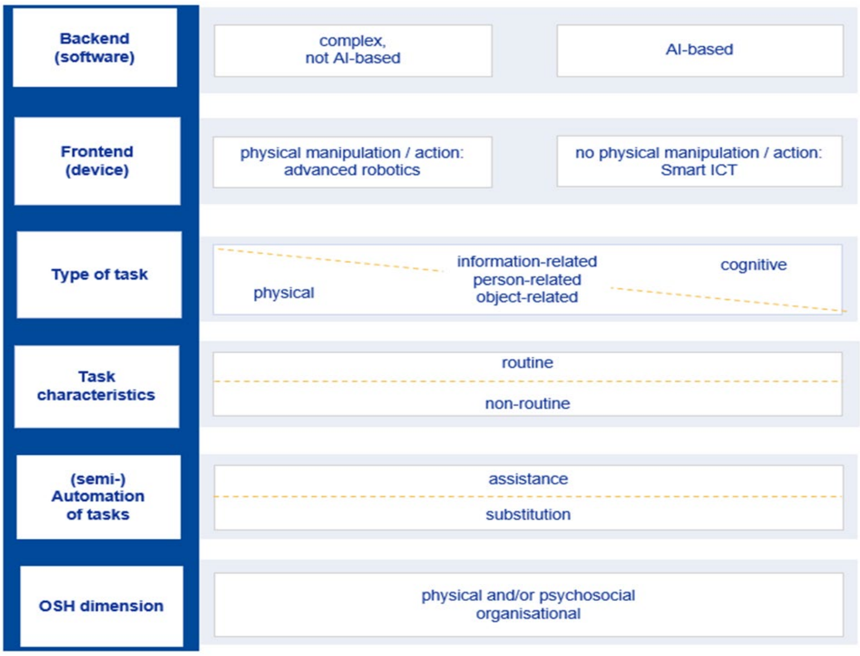
Taxonomy-based categorisation

To categorise different types of technology, a taxonomy specific for different important criteria of advanced robotics and AI-based systems was developed and published in the EU-OSHA report ‘Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health’.[1] This taxonomy includes the type of backend and frontend used and the type of task performed, as well as which category it falls under (information-related, person-related or object-related). It distinguishes between routine and non-routine task characteristics as well as the degree of automation in the forms of assistance or substitution. Finally, the taxonomy takes into account different OSH dimensions (physical, psychosocial and/or organisational) that are impacted by the technology.

Sorting items, in this case produce, requires a worker’s trained eye and quick decision-making. However, standing next to a conveyer belt performing this task repeatedly can be strenuous for the workers. The automation solution developed by this integrator automates a number of **cognitive and physical tasks through their combination of advanced robotics and AI-based systems**, previously performed by a worker. The robotic arm performs **physical manipulation** (the sorting of material), however, its movement is based on an **AI** making the decision whether the produce meets the quality criteria, which is a **cognitive task**. Here workers can theoretically be entirely **substituted** by the technology. They are no longer needed to categorise or sort the material themselves. While the system is reliable in its decisions, a human worker can still supervise the process. In addition, human and robotic sorting systems can work next to each other, as fully automating the processes is not yet always possible (full automation is a large investment). When working alongside the workers, the robotic system reduces both their **cognitive and physical workload**. The OSH implications for the technology can be **psychosocial or physical**. However, the company also takes **organisational efforts** to react to OSH implications in the form of offering training to their clients’ workers, ensuring that their technology is C-standard certified and by keeping no deterministic aspects within strictly defined bounds in line with safety requirements.

[1] EU-OSHA – European Agency for Safety and Health at Work, *Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health*, 2022. Available at: https://osha.europa.eu/en/publications/advanced-robotics-artificial-intelligence-and-automation-tasks-definitions-uses-policies-and-strategies-and-occupational-safety-and-health

Figure 1: Taxonomy for advanced robotics and AI-based systems for the automation of tasks



OSH implications

When the integrator installs a robotic automation system at any of their customers' work sites, **safety measures** are put into place to ensure OSH for workers stationed next to a robotic system. As the robotic system is a physically moving part, these safety measures aim to reduce the risk of collision or injury. If a worker enters the space of the machine, it slows down automatically or stops. The machines have well-defined **boundaries in their scope and range of motion** and, therefore, the company has assessed that no added risks for workers arise. The possibility of **unpredictability arises from the self-learning nature of AI**, which is acknowledged by the company. The above-mentioned safety area ensures that even if the system should move unpredictably, workers are not put at risk. In addition to that, workers are fully **separated** from some of the robotic systems, if safety cannot be ensured.

A possible **mental impact** discussed by the company is the fact that workers might become **stressed**, realising that the machine performs the tasks at a much **higher frequency than a human**. However, as the machine overall reduces effort needed for workers to perform sorting tasks in general, the company does not consider this a primary risk. They also have continued their health and safety management and recommendations when it comes to the robotic quality control systems compared to their previous, deterministic systems.

The company also **provides in-person training for their clients.** Here, workers who will interact with the robotic systems learn how to operate and maintain the machines safely and effectively. In addition to that, the integrator's development team takes an active design effort to create an intuitive user interface for all their systems. This intends to improve the experience of working with the system. A comprehensible user interface can contribute to OSH, as users can access needed functions quickly and effectively, including all **safety functions**.

As the AI-based systems for quality control operate through camera input, consideration regarding **data privacy** had to be made. The integrator addressed this by setting up their systems in such a way that no person-related data are collected by the system.

The company follows **EU directives** as well as **C-standards** for selective machines. C-standards are machine safety standards defining safety requirements for a particular machine or group of machines. As the scope of the AI is confined to the boundaries of the machine itself, they determined no additional OSH risks for the workers that mandate application of another specific guideline or recommendation.

Key takeaways and transferability

The use and functionality of advanced robotics or AI-based systems can differ greatly from use case to use case. However, gathering information on similar use cases and transferring applicable insights about opportunities, risks and challenges, or other lessons learned, can help companies navigate the implementation process more efficiently and successfully, especially concerning OSH.

The presented company is a special case within the scope of the case study selection. They are not the primary user of the systems, but the **integrator**. Nonetheless, there are key takeaways for OSH in this short case study. The company puts forward a special focus on **providing training** for their customers to support them in ensuring the safest use of their systems. In addition to that, **special safety measures are integrated into the system**, protecting workers from physical harm.

Noticeably, the company highlights that their **AI is strictly limited** to data related to the process, not based on the collection of worker data.

This short case study allows us to observe that OSH starts on the **level of system conception**, sharing the responsibility to create a **safe working environment between the system developer and the end user**. Continuous communication with all stakeholders involved in the design, implementation and use of the system can not only make the process more efficient but also result in a better result with regard to OSH. As each system is a custom design, OSH-related environmental factors are taken into account from the start of the design process. Good communication allows everyone involved to be aware of the challenges and opportunities of the system, as well as to know what expectations regarding function and safety are to be met by the system, and how to use the system to meet those expectations.

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