

## PRINCIPLES FOR DESIGN AND DEVELOPMENT SMART DIGITAL SYSTEMS FOR IMPROVING WORKERS' SAFETY AND HEALTH

Smart digital systems for improving workers' safety and health<sup>1</sup> are systems using digital technologies to collect and analyse data in order to identify and assess risks, prevent and/or minimise harm, and promote occupational safety and health (OSH).<sup>2</sup>

Often, these systems are based on data collection devices, such as sensors, cameras, microphones, etc., which transmits data via Bluetooth, radio-frequency identification or the Internet of things to a cloud platform. In the case of the latter, artificial intelligence (AI) and machine learning (ML) algorithms process data and translate it to information that employers can use to prevent or react to risks. Of course, there are other options too: from smart monitoring systems using augmented reality, virtual reality or mixed reality to train workers in high-risk sectors, to drones conducting remote inspections in the real estate, construction, oil and gas<sup>3</sup> or rail sector, these systems are increasingly entering the workplace.

European Agency for Safety and Health at Work's (EU-OSHA) research on smart digital systems suggests that companies and organisations can improve the safety and health of their workers using these systems.<sup>4</sup> However, certain conditions should be met. These include embedding the smart digital systems in existing OSH framework instead of using them to replace it, and understanding that together with benefits, the smart digital systems can come with limitations.

Further, EU-OSHA has highlighted that an important condition for the effective implementation of smart digital systems is ensuring that workers are fully on board when their employer introduces new monitoring technology.<sup>5</sup> It is vital that employers address workers' concerns around the potential use of the systems 'from the outset'. The concerns typically revolve around the potential transfer of responsibility for safety and health, from employers to workers, as well as the possibility of the use of the data collected for performance measurement, and the resulting potential negative implications for workers.

### About this policy brief

Based on EU-OSHA's research including studies of real-world applications and interviews with OSH professionals, workers, employers, trade union representatives, as well as product manufacturers and developers of smart digital systems and their clients, the deployers<sup>6</sup>, this policy brief outlines eight key principles for the design and development of the systems. Eight principles are proposed, intended to bring such systems closer to the needs of workplaces and workers, and therefore increase overall adoption, with the prospect of creating safer working environments.

<sup>1</sup> The term is used interchangeably with 'smart monitoring systems' and 'smart monitoring systems'.

<sup>2</sup> EU-OSHA – European Agency for Safety and Health at Work, *Smart digital monitoring systems for occupational safety and health: uses and challenges*, 2023. Available at: <https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges>

<sup>3</sup> EU-OSHA, Drones inspecting worksites of gas infrastructure operator (ID16) Available at: <https://healthy-workplaces.osha.europa.eu/en/publications/drones-inspecting-worksites-gas-infrastructure-operator-id16>

<sup>4</sup> Ibid.

<sup>5</sup> Ibid.

<sup>6</sup> In EU-OSHA's publications the terms "designer", "implementer" and "system user" are used. These publications were prepared before the AI Act ([Regulation \(EU\) 2024/1689](https://eur-lex.europa.eu/eli/reg/2024/1689)) was adopted. With the AI Act new terms such as "provider" and "deployer" have been introduced.

# Principles for the design/development of smart digital systems for improving workers' safety and health

## Focusing on OSH benefits and worker involvement

First if all, as obvious as it may seem, it is crucial to ensure that the smart digital systems and innovations are directed towards improving OSH. As technology advances, product manufacturers offer opportunities to design increasingly sophisticated systems for improvement of OSH, with enhanced accuracy, interoperability, and data analysis and presentation capabilities. Advanced technologies provide powerful tools for monitoring and managing workplace health and safety, but their potential can only be 'net' effective if they are developed with a clear focus on addressing real-world OSH challenges.

To achieve this, it is important to foster a demand-driven approach instead of a supply-driven one. This involves product developers working closely with deployers (employers) and their workers to understand the specific risks present in their workplaces – as well as the relation with existing OSH management system and co-creating systems to respond to these risks. This collaborative approach can ensure that technology directly addresses the practical needs of users – employers, OSH professionals and workers – and leads to systems that can bring meaningful impact to workplace OSH, and prevent the existence of side effects - sometimes even hindering OSH (e.g. introduction of new risks).

## Customisation

When the benefits for OSH are clear, and workers are involved, the next step is to focus on the risks to be managed with the new system. Risks can be related to several factors, such as, tasks, equipment, procedures, work practices or the working environment.<sup>7</sup> There are off-the-shelf systems on the market that can effectively cover multiple risk factors, however to have the system respond to specific risks, a certain level of customisation needs to be embedded in the design of the smart digital systems for OSH.

**Customisation is also important for catering to the specific needs of individual workers.** For example, considering gender-specific factors in the design of wearable devices such as exoskeletons could contribute to making them more inclusive.<sup>8</sup> In the same vein, accounting for workers' individual characteristics, such as their height, weight or age, can help provide them with tailor-made solutions that can improve their safety and health.



A United Kingdom-based manufacturer utilises the data from a wearable device to offer personalised training on preventing musculoskeletal risks. The training is not only tailored to individual movements but also takes into account workers' specific characteristics, including height, weight and age.



A France-based product manufacturer of smart insoles for lone workers enables them to send an invisible SOS alert to their employer by tapping their right foot against their left foot three times. The shoes need to be adaptive for the specific needs of users, which could be specific orthopaedic needs.

In this context, it is worth noting that workplaces sometimes have to adapt too, in order to accommodate the new systems. For example, a Norwegian chemicals company, which used a smart monitoring system warning forklift operators of the presence of co-workers in their vicinity, had to re-paint some of their facilities' walls black. This is because the smart digital system used infrared cameras, detecting the presence of workers based on the reflective properties of their vests, and the previous colour of the walls was interfering with the system's functionality. This example also points to the need for collaboration between product developers and their clients (employers) and worker involvement, which is discussed in more detail later in this document.

<sup>7</sup> EU-OSHA – European Agency for Safety and Health at Work, *Smart digital monitoring systems for occupational safety and health: uses and challenges*, 2023. Available at: <https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges>

<sup>8</sup> Søråa, R. A., & Fosch-Villaronga, E. (2020). Exoskeletons for all: The interplay between exoskeletons, inclusion, gender, and intersectionality. *Paladyn, Journal of Behavioral Robotics*, 11(1), 217-227. <https://doi.org/10.1515/pjbr-2020-0036>

## Data security and privacy

The majority of smart digital systems incorporate software and equipment that communicate with a cloud platform, where the data are collected and stored for analysis. This introduces concerns regarding data security for workers, their representatives and employers alike. Cyber security along with data security measures should be put in place to mitigate the risk of potential breaches by externals.

In addition to concerns about data security, issues related to data privacy are also among the most challenging when introducing a smart system for OSH at the workplace. As shown in our study and the cases, data privacy is often perceived as one the major concerns of workers when implementing a smart digital system. In this context, figure 2 illustrates potential methods to ensure the privacy of data, also referred to as 'privacy by design', like anonymisation, data minimisation and compliance. When this is not possible, alternative ways to address data privacy concerns should be sought between employers and workers or their representatives.<sup>9</sup>

Figure 1: Data privacy by design<sup>10</sup>



### Anonymisation

Anonymising personal data by assigning unique identifiers instead of workers' names.

Employing de-identification techniques such as facial or body blurring or ghosting.



### Data minimisation

Preventing the collection of data that might not be relevant for safety and health purposes.



### Compliance

Adhering to the relevant data protection laws and regulations, such as the General Data Protection Regulation (GDPR)<sup>11</sup> in Europe.

## Reliability

As the smart digital systems concern safety and health aspects of workers, it is of paramount importance to ensure that they are reliable. For example, false alarms could lead to a loss of trust as well irritation and stress, on the other hand an unreliable alarm can lead to overseeing risks and so accidents. The following figure (Figure 4) shows several layers of the reliability of smart digital systems.

<sup>9</sup> For more information, see: EU-OSHA – European Agency for Safety and Health at Work, *New monitoring systems for improving workers safety and health. Empowering safety, respecting privacy. Towards transparent new monitoring systems for improving workers' safety and health*, 2024.

<sup>10</sup> Ibid.

<sup>11</sup> Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02016R0679-20160504&qid=1532348683434>

Figure 2: Reliability aspects of new OSH monitoring systems



### Accuracy of measurement under different environmental conditions

Systems are accurate in environmental conditions such as heat, dust or humidity, which exist across different sectors.



### Ability to perform under different environmental conditions

Systems are able to withstand different environmental conditions and rough usage, in line with relevant standards, e.g. ingress protection codes.



### Fail-safe mechanisms

Systems are safe to use and have a low likelihood of malfunctioning.

EU-OSHA's research on real-world examples of the smart systems<sup>12</sup> and the development of nine case studies under this topic has revealed that product developers are increasingly focusing on these aspects. This involves seeking compliance with relevant standards, for example, related to waterproof protection, and consistently testing their products under various environmental conditions. Furthermore, the interpretation of data through AI/ML algorithms should adhere to **transparent** and rigorous processes, to ensure clarity in the journey from data to interpretation, and to avoid potential **biases**, including unintended ones. Dialogue with user representatives from the deploying companies on their needs and considerations is a key aspect.

## Compatibility and integration

Integrating smart digital systems within an existing OSH framework, including software or hardware systems, can help reduce costs and tap into new opportunities for increasing safety and health. Moreover, it enables a holistic approach to addressing safety and health concerns. Below are some examples showing how integrating new OSH monitoring systems within existing software or hardware can take place in practice.



A Sweden-based product manufacturer of a smart monitoring system, designed to alert forklift operators about the presence of co-workers in their vicinity, offers the option to connect to a forklift's software, automatically slowing it down in the event of a potential collision.



An Ireland-based product manufacturer of an AI system designed to capture unsafe events integrates this system into organisations' existing CCTV camera systems, facilitating seamless integration and more efficient (and less costly) improvement for safety and health.

Product developers are increasingly working in this direction of integrating their systems in their clients' (deployers') OSH framework. For example, a Germany-based product developer of smart gas detection systems has been working together with its clients to explore ways of integrating the data in a site-wide safety and health information management system (Figure 1), via a cloud-based platform. This way the use of safety devices can be monitored in relation to other workplace safety and health information.

<sup>12</sup> For more information, see: [osha.europa.eu](https://osha.europa.eu/en/publications-priority-area/smart-digital-systems) (n.d.). Smart digital systems. Available at: <https://osha.europa.eu/en/publications-priority-area/smart-digital-systems>

Figure 3: Embedding new OSH monitoring systems in an existing OSH framework



At the same time, a United States-based product manufacturer has reported multiple possibilities of having their software-as-a-service (SaaS) interact with their clients' safety systems or equipment. An illustrative example would be activating an organisation's air handler when the SaaS detects that air quality in the facilities has reached a hazardous level for workers' safety and health.

Exchange of information between smart digital systems and the existing technical (software and hardware) as well as non-technical organisational (OSH guidelines, training and toolboxes) OSH systems, with risk assessment in its basis, emphasises the need for product developers to work together with their clients (employers) to design tailor-made solutions.



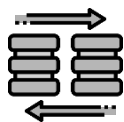
Smart digital systems can enhance but not substitute an existing OSH framework. Organisations should therefore use them as part or an extension of their existing OSH framework, in line with the hierarchy of controls.

This is to prevent a potential transfer of responsibility for safety and health to individuals, resulting in potential negative implications for workers.

NB: despite all effective possibilities of integration, all potential for perceived or real interference associated with the use of collected data for performance assessment should be avoided.

### Scalability of the implemented solution

Scalability is another aspect to consider when designing new smart digital systems for OSH monitoring, as it is an important issue, especially for large organisations planning to implement such systems in multiple facilities. For example, if new functions, such as contact tracing, geofencing or others, become available, they need to be integrated with the existing systems. Potential migration issues could lead to additional and unforeseen migration needs and costs, and so present a risk for existing users.



When designing the OSH management systems, it is recommended to anticipate scalability, to prevent potential migration risks for existing users when new features become available.

### User friendliness

While often apparent, the aspect of user friendliness in smart digital systems is sometimes underestimated. Ensuring **user-centred design** can mitigate non-compliance and increase overall acceptance. In this context, practical considerations, such as the ease of mounting and dismounting, e.g. for the case of exoskeletons for breaks or emergencies, need careful attention. Equally, design of wearables that do not hinder movement or introduce additional risks for workers, such as the risk of collisions due to cumbersome design, must be taken into consideration.

In addition, although the actual software and hardware development of smart digital systems might be sophisticated, there is a need for their interface to be **intuitive**, so that it is easily understood by workers,

regardless of their educational level. When it comes to wearables, sound or vibration alerts notifying workers about potential hazards appears to be one of the most common ways to achieve this. Intuitive workplace resources such as small videos or posters featuring workers themselves can also contribute to workers' understanding of the respective systems.<sup>13</sup>



A France-based product manufacturer has developed a smart monitoring system with man-down functions and two-way alert communication between workers and employers, integrated into insoles. The manufacturer has worked with an established insoles developer to prioritise comfort in product design. The simplicity of wearing the shoes, without the need for additional equipment, coupled with the comfort, has proven to be an effective strategy in addressing potential non-compliance among workers.

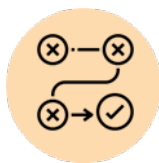


A United Kingdom-based product manufacturer has developed a smart monitoring system for preventing hand-arm vibration (HAV) that provides audio and haptic alerts to workers when they are exceeding the relevant OSH limits for vibration.

## Cooperating with organisations

Close collaboration between the developers and the deploying organisations – the workplace - has been identified as a common practice that can help product developers in bringing their systems closer to the specific needs of employers and workers at workplaces, and to troubleshoot potential questions as well as discover new possibilities for improving safety and health. Figure 4 shows some potential ways of collaboration. These are typically offered as a suite of services along with the smart digital system by product manufacturers.

Figure 4: Cooperating with organisations



### Trial periods

Trial periods can help product manufacturers better understand the specific needs of their clients (employers and workers at workplace) and adapt their products.



### Customer support

Continuous customer support including workplace resources services have been cited as very important from organisations in terms of addressing potential questions.



### Trainings/Workshops

On-site or online trainings for OSH professionals and workers can help to address potential questions on the spot.



A Germany-based product manufacturer of smart gas detectors conducts 'discovery technology workshops'. In these, representatives of the product manufacturer sit together with OSH professionals from their clients to discuss ways in which technology can tap into opportunities for increased health and safety (see also Figure 1).

<sup>13</sup> EU-OSHA – European Agency for Safety and Health at Work, *Smart digital monitoring systems for occupational safety and health: workplace resources for design, implementation and use*, 2023. Available at: <https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-workplace-resources-design-implementation-and-use>

## Conclusions

This policy brief is based on EU-OSHA's research into real-world applications of smart digital systems for OSH in workplaces. In the course of the research, the team conducted interviews with a self-selected group of OSH professionals and governmental, worker, employer and trade union representatives, as well as product manufacturers of smart digital systems and their clients. These discussions, along with insights gathered from a high-level seminar held in Bilbao, Spain, in 2023,<sup>14</sup> form the basis of this policy brief.

The policy brief has provided an overview of eight principles that product manufacturers/system developers can leverage to bring smart digital systems closer to the (OSH) needs of employers and workers at workplaces and enhance their overall uptake. These include the need to provide **custom-made, compatible and interoperable solutions, which respect data security and privacy, are scalable, reliable, transparent and user friendly, and focused on addressing real-world workplace risks**. To fulfil these conditions and propel potential future capabilities of smart digital systems, our research highlights that **collaboration between product developers and their clients, the users (employers and workers at workplaces) is essential**, both at the design but also at the deployment stage.

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<sup>14</sup> For more information, see: euosha-events.eu (2023). High-level Workshop Smart Monitoring Systems. <https://www.euosha-events.eu/smart-digital-systems/>