Smart digital systems: implementation guide for improving workers' safety and health

European Agency
for Safety and Health
at Work

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1 Introduction

This implementation guide provides practical advice to employers aiming at designing **workplace resources such as guidance documents** (e.g. leaflets, posters, videos), training material and others to support the **introduction and deployment of smart digital systems for the improvement of occupational safety and health (OSH)** (e.g. wearables such as wristbands, clothing such as smart boots and smart vests, camera-based systems). Furthermore, it presents a number of cross-cutting issues and general considerations that can be useful to improve safety and health through smart digital systems.

The implementation guide benefits from consultations with over 30 key stakeholders, including product manufacturers, developers, employers, workers, OSH professionals and trade unions across Europe and the world, as well as from a comparative analysis of real-world examples of workplace resources. These stakeholders have been part of the European Agency for Safety and Health at Work (EU-OSHA) project Overview of research and practices in relation to smart digital monitoring systems for occupational safety and health from which this publication draws on.[1,2] The examples analyzed present actual workplace resources from product manufacturers of smart digital systems and OSH monitoring systems and employers implementing the systems, and cover a wide range of sectors, including industrial facilities (e.g. warehousing, manufacturing, retail), construction, engineering, mining, agriculture, healthcare and others.

The focus of the guide is to provide practical and useful tips on how organisations can either design or improve their workplace resources to support the introduction of smart digital systems.

The implementation guide is structured as follows:

- **Section 2** provides contextual information on smart digital systems. In particular, the section introduces smart digital systems as well as an overview of their technologies and the workplace risks that they can address.
- **Section 3** provides a list of good practice criteria that employers and companies can consider when designing workplace resources that can support the introduction of smart systems. The section includes suggestions on how to apply these criteria, also using examples of workplace resources applied by employers and companies in the real world.
- **Section 4** provides a list of cross-cutting dimensions that can improve OSH at the workplace through smart digital systems. Cross-cutting dimensions include placing emphasis on worker involvement, existing OSH procedures, providing on-the-job training, and maintaining an open channel of communication between workers and employers and OSH professionals/team leaders.
- **Section 5** presents general considerations that employers and OSH professionals/team leaders can consider before introducing smart digital systems at the workplace.
- **Section 6** summarises the main conclusions of this guide.

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[1] For more information (including a list of key informants (stakeholders) and resources), see:
https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-workplace-resources-design-implementation-and-use

[2] See: https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges

2 Overview of types of smart digital and associated workplace resources

This section provides an overview of smart digital systems for OSH and presents the types of workplace resources that can support their implementation.

Smart digital OSH systems are those using digital technologies to collect and analyse data to identify and assess risks, prevent and/or minimise harm, and promote OSH.[3] 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, translating them into usable information that businesses can use to prevent or react to risks.

In other cases, they can be stand-alone wearable devices such as exoskeletons, or embedded in clothing, personal protective equipment (PPE), and industrial equipment (e.g. vehicles) or facilities (e.g. working space). Introducing such systems at the workplace can help employers augment their existing OSH procedures and improve the OSH of workers through numerous ways. In principle, the main ways in which these systems improve OSH are through providing on-the-job training as well as through preventing risks and reacting to them.[4]

In terms of preventing risks, the systems can alert workers when they are performing a task (e.g. lifting a box) in a non-ergonomic or otherwise dangerous fashion and provide them with on-the-job training. In addition, they can send aggregate data to OSH team leaders and employers, helping them to identify the sources of the risks and (re)design their workplaces to manage them. In addition, such systems can also react to risks. For example, some systems collecting geolocation - or even biometric- data can reduce the time of rescue operations in occupations with high OSH risk, such as mining and firefighting.

Overall, smart digital systems can reduce a wide range of risks (see also Figure 1) in various sectors and especially those having a high OSH risk level. However, there are also challenges concerning data collection, interpretation and use. In this context we mention specifically challenges related to the blurring boundaries between OSH and performance measurement. They must be handled with great care.[5,6] The benefits and risks of the smart digital systems are described in more detail in the related EU-OSHA publications.[7]

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[3] For more information, see: https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges and: https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-workplace-resources-design-implementation-and-use

[4] For more information, see: https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges

[5] Ibid.

[6] For more information, see EU-OSHA's (2022) workshop's recording and presentations: New monitoring systems for improving worker safety and health. An overview of challenges and opportunities. https://www.euosha-events.eu/Digitalisation/WS_OSH_Monitoring/#introduction

[7] For more information, see: https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges

Figure 1: Workplace risks[8]

Ergonomic
(repetitive movements, extreme postures)

Chemical
(inflammables, toxics, emissions)

Workplaces can have several health risks

Physical
(extreme temperatures, noise, vibrations, radiation, lighting)

Psychosocial
(work-related stress, fatigue, anxiety)

Safety
(traffic-, work-, equipment-related)

To support the implementation process (i.e. deployment) of smart digital systems, employers and companies can use a wide range of workplace resources. Workplace resources can include any type of product and activity that the product developers or the deployers (employers implementing the system) use to enable workers to successfully accomplish their tasks and goals while enhancing their safety[9].

These products to promote activities and awareness can be audio, visual or written documents, and the activities can be in situ or online trainings, toolbox talks or informal briefings. A recent EU-OSHA publication[10] has made a critical appraisal of available workplace resources. Drawing on this publication, this implementation guide presents a number of ex-ante good practice criteria and in addition presents a number of cross-cutting issues and general considerations that are important to tap into the full potential of these systems. These cross-cutting issues and general considerations show that the smart digital systems can augment but not replace existing OSH procedures, and that workplace resources are useful but not the only solution to effectively integrate such systems at the workplace.

3 Criteria for developing workplace resources

This section presents a number of ex-ante good practice criteria for employers and companies aiming to develop workplace resources to introduce smart digital systems at the workplace. Employers are not necessarily expected to produce one workplace resource covering all of the below criteria. They can inform different workplace resources with these criteria, as appropriate.

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[8] Figure based on information from: ILO. (2016). *Code of practice. Safety and health in ports* (Revised 2016). International Labour Office, p. 406. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/normativeinstrument/wcms_546257.pdf

[9] Based on information in: Rick, V. B., Rasche, P., Mertens, A., & Nitsch, V. (2022). Workplace Health Promotion: mHealth as a preventive mediator between psychosocial workplace characteristics and well-being at work. https://www.workingage.eu/wp-content/uploads/2022/04/Rick-et-al.-2022-Workplace-Health-Promotion_mHealth-as-a-preventive-mediator-between-psychosocial-workplace-characteristics-and-well-being-at-work.pdf

[10] EU-OSHA – European Agency for Safety and Health at Work, *Overview and assessment of workplace level resources*, 2022.

NB: the workplace resources are important to support the implementation process of the systems, however most important is to emphasize that workplace resources should ensure workers are involved and engaged from the beginning and during the implementation process, and not take over or substitute in any way worker participation.

3.1 Keep it informative

The introduction of smart digital systems for OSH at the workplace is relatively new, and requires significant sharing of information between employers and workers to fully inform about their use. This information is covered in the sections below.

3.1.1 Explain the workplace risks

An important element that workplace resources can cover is the description of the risk that the smart digital system is able to address. Generally, risks can relate to workers' activity/task, equipment (e.g. a work environment (e.g. site layout) and work organisation (e.g. work in shifts).[11] Box 1 provides information on examples of resources describing workplace risks.

Box 1: Tips & Tricks - Learning more about risks in specific sectors

OiRA – Online interactive Risk Assessment – is a web platform that enables the creation of sectoral risk assessment tools in a number of languages in an easy and standardised way. It is developed and maintained by the **European Agency for Safety and Health at Work (EU-OSHA)** and it is based on the Dutch risk assessment instrument RI&E. OiRA sectoral tools are accessible through an interactive website. [12]

The **International Labour Organisation (ILO)** codes of practices provide in detail a list with workplace risks across several sectors. Examples include: textiles, clothing, leather and footwear, shipbuilding and ship repair, ports, agriculture, opencast and underground mines, use of machinery. For more information, visit ILO's website.[13]

Box 2: Tips & Tricks - Learning more about risks

EU-OSHA and OSH actors at national level such as ministries, labour inspectorates, institutes, universities, prevention services etc. can also provide useful information in relation to workplace risks and ways in which companies can address these risks.

Examples of EU-OSHA e-guides/e-tools on OSH management at the workplace include[14]:
- Dangerous substances e-tool
- E-guide on vehicle safety
- E-guide on managing stress

3.1.2 Explain the purpose and use of the system

Explaining the purpose of smart digital systems, engaging and involving workers in how the digital tool can be used to enhance OSH, is important for an effective implementation at the workplace.

In principle, this should include workers in the testing, selection and optimisation of smart digital systems and maintain an open channel with them to listen to and answer potential questions around these systems. However, workplace resources, for example, posters, videos or presentations that help workers familiarise themselves with these systems, can also contribute. As shown in section 3.2 it is

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[11] ILO. (2016). *Code of practice. Safety and health in ports (Revised 2016). International Labour Office, p. 406.* https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/normativeinstrument/wcms_546257.pdf

[12] https://oira.osha.europa.eu/en

[13] ILO. (n.d.). Code of Practice – Normative instruments https://www.ilo.org/ilo-codes-practice-and-guidance-documents#:~:text=Codes%20of%20practice%20set%20out%20practical%20guidelines%20for,of%20national%20laws%20or%20regulations%2C%20or%20accepted%20standards

[14] For more information on the e-tools/e-guides: https://osha.europa.eu/en/tools-and-resources/e-guides

critical to keep these workplace resources simple and include a step-by-step instructions approach and visual cues.

Box 3: Tips & Tricks - Using videos and in situ briefings to explain the purpose of OSH smart digital systems
While **prior worker consultation and in situ briefings/presentations with OSH professionals are essential** to help workers know and understand smart digital systems, short videos/posters can also be an effective way that can help with understanding. If you are looking for videos that can serve as sources of inspiration, you can see how: ▪ a Swedish developer explains, in an under-one-minute video, how workers can use its new OSH monitoring system to address site-traffic accidents;[15] and ▪ a United Kingdom developer explains ergonomic risks, their potential causes, the purpose of its new OSH monitoring system and how workers can use it with a step-by-step guide: all in a three-minute video.[16]

3.1.3 Explain use of data

Our research suggests that there are several ways to address concerns around the misuse of personal data at the workplace which is a continued concern among workers.[17] It is important to address these issues to avoid misunderstandings and ensure a level of trust in these systems. This includes explaining at a minimum the elements shown in Figure 3.

Box 4: Common questions around data
▪ **What** is the purpose of data collection? ▪ **What** kind of data are collected (e.g. movement, biometric)? ▪ **How** will the employer and company use the data? ▪ **Who** has access to the data? ▪ **How** will the data be stored and **what** provisions are in place to keep them safe? (if any) ▪ **Are** there any (negative) implications for the worker?

An example of how you can go about explaining issues around data is shown in Box 5.

Box 5: Tips & Tricks - Addressing considerations around the use of data: an example from Sweden
Tripartite involvement remains the most effective way to address issues in relation to data. A Swedish mining company using smart digital system records all the data on a hard drive owned and accessed only by the workers' union. In exceptional circumstances (e.g. accidents), geolocation data are also available to other parties (e.g. rescue teams) in order to trace workers and improve the operation rescue time. ▪ Even when there is no legal obligation for prior worker consultation, there is strong evidence from both employers and product manufacturers that such consultation is essential for the successful introduction of smart digital tools and new OSH monitoring systems. ▪ Often, employers can opt for OSH monitoring tools with no personal identifiers, which can address considerations around the use of data.

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[15] To access the source, follow this link: https://www.youtube.com/watch?v=TMbphhyvr0Y
[16] To access the source, follow this link: https://www.youtube.com/watch?v=rrX8-oJhQzc
[17] EU-OSHA – European Agency for Safety and Health at Work, *Overview and assessment of workplace level resources*, 2022.

3.1.4 List responsibilities

Clarifying process and responsibilities for OSH at the workplace is another piece of the puzzle when it comes to introducing smart digital systems at the workplace. Clarity on responsibilities and management is relevant for both workers and employers. Workers need to know their rights and obligations in relation to OSH as well as the persons within their organisation who they can reach out to in case they experience issues with the smart digital tool or OSH monitoring systems. Employers must know their legal obligations towards the OSH of workers and ensure that smart digital tools cannot be used to delegate their responsibilities to the system.[18]

Box 6: Tips & Tricks - Including and updating a FAQ section in workplace resources

Including a FAQ section in workplace resources can serve as a useful point of reference that can help workers find answers to the most common questions. Remember: keeping the FAQ section relevant is equally important, so make sure to consult workers and/or product manufacturers at regular intervals to update the FAQ.

3.1.5 Make limitations clear

Smart digital systems often come with inherent limitations. Listing these limitations is important to keep workers vigilant and avoid the misuse of these systems, which can have the opposite, that is, negative, effects for OSH. Employers should not discount their standard OSH procedures but rather use the smart digital tools and OSH monitoring systems to augment them.

Box 7: How can smart digital systems cause harm? A potencial example

Introducing smart digital systems at the workplace can have negative implications if the limitations of these systems are not made clear to the workers. For example, a major chemicals company that has introduced a smart OSH monitoring system that warns forklift drivers when fellow workers are in their proximity stressed how important it is that drivers remain vigilant. This is because the system is based on an infrared camera that uses the reflective properties of workers' vests in order to warn the forklift drivers. Therefore, in cases where workers might hold a box that covers these reflective properties, the system might not work. Similar examples exist in many smart digital systems. Therefore, it is important to list them in order to ensure that workers tap the full potential of new systems and do not over-rely on them.

3.1.6 Keep it short and simple

Keeping workplace resources short and simple is the common standard across all industries. Often, a simple poster or a video including step-by-step guides and visual cues can be very effective in helping workers understand how to use (and not use) smart digital tools and OSH monitoring systems.

Making a workplace resource short and simple aims at making it easily understandable. This is particularly important as some systems might be complex. On these occasions, the complex information can be considered to be mainly for OSH managers or e.g. IT departments and develop direct information for workers using these systems day to day.

Equally, it is necessary to consider language requirements. For example, in construction sites including workers from multiple nationalities, translating resources into different languages is essential to help everyone understand OSH procedures. While making workplace resources short and simple is

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[18] For issues around workers' and employers' responsibilities in relation to safety and health, see also: Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31989L0391

important, for OSH professionals or technical staff, technical documents (e.g. in relation to data collection, storage and interpretation) can be more elaborate.

Box 8: Tips & Tricks - Using behavioural science to promote OSH

Did you know that behavioural science can help you shape your workplace resources and achieve safer behaviour at your workplace? All you need to do is to go EAST (Easy, Attractive, Social, Timely). Learn more in the short guide of the Behavioural Insights Team: Applying behavioural insights to make workplaces safer.[19]

3.2 Make it relatable

Making resources relatable to workers can help them to act on the information that is available in these resources. This points to the importance of involving workers in the design of workplace resources and/or seeking their feedback to optimise existing workplace resources. There are several ways through which companies can work in this direction. An example is shown in Box 9.

Box 9: Tips & Tricks - Involving workers in the design of workplace resources

- Seize opportunities such as the World Day for Safety and Health at Work to bring workers together and engage them in co-creation exercises in order to design workplace materials fitting their needs.
- Consider using videos from the actual workplace to probe discussion on safety issues. For example, if you work at an industrial facility (e.g. warehousing, manufacturing, retail), consider using short videos from the actual facility (e.g. explaining the most important risks in relation to internal transportation). Then, use this video to probe a discussion on how risks affect your team and to identify what other risks might be present and what measures you can take to manage them.

Another way to make resources relatable is to feature the company's own workers on them.

3.3 Use a multimedia strategy

A final tip when it comes to introducing smart digital systems, and more broadly, OSH measures, is to follow a multimedia strategy. In practice, this means using different types of workplace resources (posters, videos, case studies) to inform workers about how they should use these systems and treat OSH at work. Considering a mix of online and print resources can also be useful as despite the increasing use of online media, workers in some sectors might still favour print resources. Some tips on how you can create your own resources, with relatively limited to no costs, are shown in Box 10.

Box 10: Tips & Tricks - Using low-cost tools to create workplace resources

There are a number of open source or otherwise low-cost tools that can help you co-create and design workplace resources even if your budget and graphics (design) knowledge is limited. Some suggestions are available below:

- For co-creating workplace resources with workers:
  - Mentimeter
  - Miro

- For creating workplace resources:
  - Canva
  - Flaticon

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[19] Kolker, E., Algate, F., & Tilleard, R. (2019). *EAST for Health & Safety. Applying behavioural insights to make workplaces safer*. The Behavioural Insights Team. https://www.bi.team/wp-content/uploads/2019/10/2019-09-30-BIT_EAST-for-Safety_Full-Report.pdf

4 Cross-cutting dimensions

It is important to note that workplace resources should be seen as a piece of the puzzle, but not the complete solution to effectively deploy smart digital tools or new OSH monitoring system. For this, employers and companies should take into account several other dimensions. First of all, in every stage from the design to the implementation worker involvement should be first priority, sharing and receiving information. This section describes these issues and explains why they are important in terms of improving OSH at the workplace.

4.1 Place emphasis on existing OSH procedures

Smart digital systems can augment but not replace existing OSH procedures. This is important as introducing such systems to replace existing OSH procedures or to reduce OSH professionals or other staff is likely to have negative implications for the OSH of workers. In such scenarios, a risk assessment procedure should be initiated.

For example, while in theory a smart system could reduce the need for a companion or an additional worker in a high-OSH-risk task, but in practice letting a single worker perform such a task might have side effects on their psychosocial wellbeing. Therefore, it is important to consider the net effect when it comes to OSH. Equally, it is important to reiterate that employers and workers should not be over-reliant on the systems as these often have limitations (e.g. in relation to technology), and neglecting those can have negative implications for OSH. For example, it should be clear to workers using exoskeletons that despite improving productivity, the main purpose of these exoskeletons is to improve OSH. Therefore, using these systems to improve throughput might still cause injuries.

Recent evidence from companies and product manufacturers corroborates the above principle and suggests that companies having robust OSH procedures and placing emphasis on OSH are more likely to effectively integrate smart digital systems or new OSH monitoring systems at the workplace than companies that do not. In this context, it is advisable to have in place an OSH management system based on the hierarchy of controls and maintain your OSH competences on the ground.

Figure 2: Hierarchy of controls[20]

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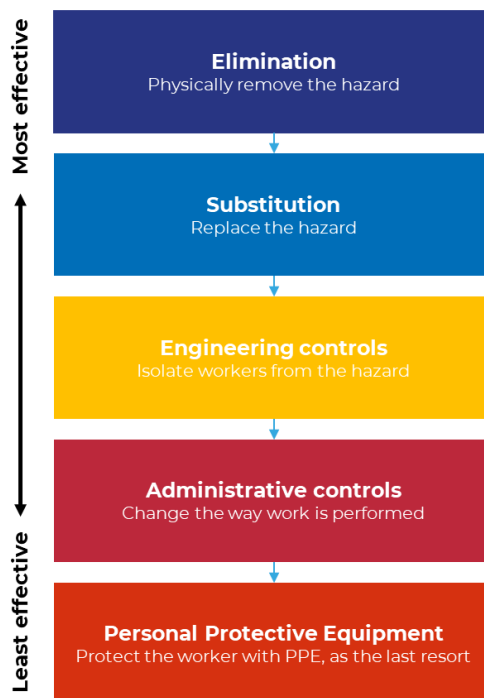
[20] Adapted from: ILO. (2021). *Exposure to hazardous chemicals at work and resulting health impacts: A global review*. International Labour Office, p. 69. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---lab_admin/documents/publication/wcms_811455.pdf

4.2   Promote on-the-job training

Some smart digital tools for OSH monitoring provide on-the-job training to workers. As mentioned earlier, some of these systems can inform workers when they are performing a task in a harmful way and provide them with feedback on how to improve task performance. Combining on-the-job training from such systems with training from OSH professionals or product manufacturers on the ground can be an effective way to reduce workplace risks. A testimonial from a worker in a logistics company in North America using a smart digital system providing on-the-job training is shown below:

> *"When I'm lifting wrong, it lets me know. The first day I had the device it was just barking at me all day long. After two weeks, it was all good — I got better at lifting packages and I rarely see the sensor flash or feel it vibrate anymore. But when it does, I pay attention to what I am doing".*

On-the-job training can be particularly effective in reducing risks at the workplace, with several manufacturers of the new systems showing through case studies the potential positive effects of such training across a wide range of sectors, including industrial facilities (e.g. warehousing, manufacturing, retail), construction, engineering, health and others. Often, such systems can personalise training depending on the users' characteristics (height, weight, age and others).

Overall, while it is useful to take case studies with a certain degree of circumspection, as they are often related to marketing purposes, they can still be a source of information around the potential of smart digital systems across real-world companies in a wide range of sectors.

Generating insights from smart systems can also help OSH professionals to better understand workplace risks and optimise the workplace or perform on-the-job trainings to reduce these risks.

4.3   Go for the walks and the talks

Maintaining an open channel of communication between employers, OSH professionals and workers is perhaps the most effective way of integrating smart digital systems at the workplace. This has been reaffirmed by product manufacturers and employers, who suggested that companies having OSH professionals on the ground working together with workers are more likely to effectively implement new OSH monitoring systems at the workplace. For example, an OSH manager in a high OSH risk sector said:

> *"I think that the best way of integrating new OSH monitoring systems at the workplace is actually doing the walks and the talks on the premises. Talking to workers and giving good and bad examples. In small facilities, it's easy to just collect everyone, have a talk and discuss problems".*

Box 11: OSH Leadership and new OSH monitoring systems

Next to maintaining an open channel of communication between workers and OSH professionals on the ground, it is important to provide clear steering and direct communication from the OSH leadership for all issues that are critical for OSH.

Another OSH manager in a high OSH risk sector noted:

> *"If it is something that you really want workers to take action on, then they need to be addressed personally. And in those cases, we would go to the teams at stake, and make sure that we communicate directly with them, ask them for feedback, and make sure that they really understand the OSH procedure … Depending on the topic, you need to make sure that you have direct communication and make sure that everyone understands the [OSH] procedures".*

In companies with plants in multiple locations, establishing a learning mechanism (e.g. peer learning including OSH managers and/or workers across plants) can also help to effectively integrate smart digital tools and OSH monitoring systems at the workplace and reduce risks.[21]

5 General considerations on smart digital systems

This section lists cross-cutting general principles that companies should take into account before introducing smart digital system for OSH at the workplace.

5.1 Understand workplace needs

The first criterion before employers start introducing a smart digital system at the workplace is understanding workplace needs. What are the main safety issues that need to be addressed and what measures are available to address them? The first step to answer this question would be to involve both workers and OSH professionals in discussing risks and mitigation measures following the principles of the hierarchy of controls.

Taking on board workers' and OSH professionals' views can help you decide if a new system can reduce risks. However, it is important to manage expectations as to what these systems can and cannot do as a single system cannot provide the solutions to multiple OSH risks. Here, it is also important to note that on some occasions, smart digital systems might cause unintended risks that can be more difficult to solve than the risks they intended to address. For example, an exoskeleton that is difficult to dismount might cause a risk in a case where an evacuation of plant facilities is necessary. Therefore, a careful consideration of such unintended risks is important.

Deciding which smart digital system is appropriate for a company can be a challenging task for an employer. However, developers have the availability of case examples from existing applications, while they often offer trial periods. In these, developers can effectively support the implementation through in situ visits and training. In these trainings, you can identify issues and optimise the performance of the system.

Box 12: Understanding workplace needs

When thinking about OSH, it is important to keep in mind the hierarchy of controls as often risks can be eliminated at an early stage.

- Simulators of human tasks can help to perform ergonomic evaluation of a task sequence as well as to validate and optimise assembly sequences
- In a similar fashion, smart digital systems can give you insights on where risks are likely to occur, so that you can optimise your workplace layout.

5.2 Appreciate socio-cultural and work context

Understanding the socio-cultural and the broader work context is also important to consider when introducing a smart digital tool and OSH monitoring system at the workplace.

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[21] Information based on stakeholder consultation.

Socio-cultural differences exist between but also within countries and sectors. For example, a key informant stated that 'old workforce (in the shipping sector) has done things a certain way for a long period of time, and despite the logic of new additions in relation to OSH it is likely to go back to what it always did.' Consequently, in some sectors there might be a risk of non-compliance. Similarly, workers in some sectors might feel that smart digital tools or systems slow them down or cause discomfort. Therefore, there is a risk of non-compliance. Finally, workers might also be resistant to use such systems for other reasons, including religious or cultural ones (e.g. workers might be resistant to having their beard trimmed to wear a respirator).[22]

Overall, considering the socio-cultural and work context through having discussions at sectoral or company level is key. Here, useful advice is to embed the safety in job duties as opposed to having job duties and then safety. In other words, there is a need to shift the mindset of workers towards making safety and health part of the job.

5.3   Place workers at the centre of the process

The research suggests that to effectively deploy and integrate smart digital systems at the workplace for OSH, workers should be placed at the centre of the process. Some ways to involve workers is having them test, select and optimise the systems, co-create workplace resources, and discuss with OSH professionals' potential safety or health issues. Both developers and employers implementing smart digital systems consulted have corroborated this argument and strongly suggested that top-down solutions are less likely to be effective on the ground.

A good case example comes from a Swedish mining company that placed in common spaces such as canteens and coffee areas the equipment, so that workers can test them, provide feedback and act as their ambassadors. This is important, as having systems for workers without workers can lead to limited acceptance, as well as produce no or reverse effects for OSH. Last, but not least, it is important to act on the information from the smart systems, and, as reiterated before, integrate them in a holistic OSH management plan. One of the analyzed examples showed how to A useful way to help to get a full overview of the risks at your workplace by including an aggregate score of risk levels.

6   Conclusion: Towards a healthier and safer workplace

This implementation guide maintains that in order to effectively integrate smart digital systems for OSH at the workplace, there are three important elements to consider, as shown below:

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[22] Based on interview data.

Table 1: Summary of key messages

Puzzle pieces to integrate smart digital tools and OSH monitoring systems

Workplace resources	- Workplace resources need to be informative, short and simple, and relatable. - There are several low- to no-cost resources that can help you design resources. - Consider co-creating resources with your workers. - Consider a multimedia strategy (posters, videos, in situ trainings).
Cross-cutting issues	- Do not neglect existing OSH procedures. Often, these can be in themselves enough to eliminate risks at the workplace. - On-the-job training is important to reduce risks. - Maintain an open channel and nurture shared learning with workers. - Consider initiating/engaging in cross-company or cross-sectoral peer learning activities.
General considerations	- Understand what the real needs are at your workplace, involve workers and manage your expectations as to what a new system can help you achieve. - Appreciate cultural or other types of specificities at the workplace to ensure acceptance. - Keep workers as users of the system alert about OSH risks, as over-reliance on new OSH monitoring systems can result in unintended consequences. **Place workers at the heart of the process** through involving them in testing, selecting and optimising new OSH monitoring systems, co-creating workplace resources, and discussing with OSH professionals' potential issues affecting safety and health.

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