SMART DIGITAL SYSTEMS FOR IMPROVING WORKERS' SAFETY AND HEALTH

EVENT RECOGNITION FOR IMPROVED SAFETY MANAGEMENT

1 Introduction

Smart digital systems and technologies entering EU workplaces are reshaping work environments for workers and employers alike. Innovations in smart wearables, exoskeletons, artificial intelligence (AI), machine learning (ML), internet of things (IoT), virtual and augmented reality (VR and AR), among others, are giving new opportunities for preventing and responding to workplace risks.

As part of EU-OSHA's occupational safety and health (OSH) overview programme (2020-2023)[1], EU-OSHA has examined the challenges and opportunities of smart digital tools and monitoring systems for improving workers' safety and health. These systems, leverage digital technology to collect and analyse data in order to identify and assess risks, prevent and/or minimise harm and promote OSH.[2] EU-OSHA has categorised such systems into proactive (preventive) and reactive, albeit acknowledging the potential overlap between the two.[3] EU-OSHA further provided an overview of the risks and opportunities associated with these systems[4] and explored the workplace resources that could ensure their safe and healthy use.[5]

In order to investigate the practical implementation of smart digital tools and new OSH monitoring systems for improving workers' safety and health, EU-OSHA has developed a number of case studies. This set of case studies includes both cases of smart digital systems at the level of design/development and cases of companies implementing the systems. The case studies accordingly investigate aspects related to the design/development stage and to the implementation stage. OSH aspects including worker's involvement was considered in all case studies taking into account the type of case study. Further all case studies look at possible drivers, barriers and success factors for safe and effective implementation.

To develop these case studies, apart from desk research, a number of interviews with key informants were conducted, including workers' representatives, safety officers, employers and representatives of industry associations. In addition, at company level, up to five interviews were conducted with operators, data protection officers, health and safety engineers, managers, work councillors and technology officers. The interviews had a duration of 1-1.5 hours each and were performed in the participants' native language, if possible, or alternatively in English, an interview guide, while the results of the interviews were anonymised. The case studies referring to designers' results do not contain detailed information on workplace implementation, as there has been limited collection of information from companies in which the systems are installed.

In total 15 cases were identified, and preliminary information was collected for these through a questionnaire, hereafter, nine of them were further developed into case studies.

[1] For more information, see: osha.europa.eu (n.d.) Digitalisation of work. Available at: https://osha.europa.eu/en/themes/digitalisation-work

[2] EU-OSHA (2023). Smart digital monitoring systems for occupational safety and health: uses and challenges, https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-uses-and-challenges

[3] Ibid.

[4] Ibid.

[5] EU-OSHA (2023). Smart digital monitoring systems for occupational safety and health: workplace resources for design, implementation and use, https://osha.europa.eu/en/publications/smart-digital-monitoring-systems-occupational-safety-and-health-workplace-resources-design-implementation-and-use

2 Description of the smart digital system for OSH

2.1 General company description (developer)

This case study refers to a computer vision (CV) system designed to detect and predict worker safety risks in various work environments such as manufacturing facilities, warehouses and ports. The system was developed by an Ireland-based manufacturer employing 40 people across Europe and North America. The manufacturer supports health and safety professionals in making proactive safety decisions through artificial intelligence (AI)-powered technology, providing greater visibility of unsafe behaviours in organisational facilities.

2.1.1 What is the system about?

Recent advancements in processing power and machine learning have propelled image processing to a stage where it is possible to identify objects and workers in real-world images and thus detect workplace hazards ex ante. The Irish manufacturer of this case study has leveraged these technological advancements to design an event recognition system that can anticipate risks and improve safety reporting in different working environments such as manufacturing, transportation and storage, retail, waste management and others.

The tool for event recognition is a safety monitoring tool that leverages the power AI to improve safety reporting in different working environments and improve safety management. The tool can be integrated into an organisation's existing closed-circuit television (CCTV) network, and automatically identifies safety-compromising events as they occur. It then records these events, enabling safety managers to analyse them and generate reports enriched with data-driven insights.

2.1.2 How does the system look and work?

Event recognition for improved safety management allows CCTV cameras to understand and identify risks in a facility, by using the workplace's specific context to build custom safety rules. The system's software plugs into a local network, connects to cameras, and processes and stores data on-site to ensure security and privacy. The system's features and operation are briefly described as follows:

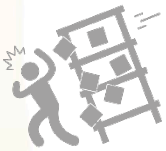
- The system can teach the cameras how to identify risks at the workplace using customised safety criteria.
- Using an intuitive event log, the system can record non-compliant events across the entire workplace, providing valuable insights for safety assessments.
- The system offers reporting and dashboard capabilities to generate comprehensive safety audit reports.
- To promote continuous improvement, the system includes storyboard functionality. This feature allows environment, health and safety teams to collaborate on lessons learned from safety events, implement corrective actions and support a proactive approach to safety management.

Figure 1: Event recognition for improved safety management

2.1.3 Technologies employed in the system

The system's main technology is CV that is based on AI (see Figure 2). This technology provides data on accidents and identifies ways to reduce risk, especially in the logistics, retail and manufacturing sectors. It can therefore be classified as a proactive monitoring system[6] that can be particularly effective in preventing the following risks:

- **Collisions with moving vehicles.** The system provides data on the frequency of pedestrian–vehicle interactions, detects when high-visibility clothing is not worn in mandatory areas and identifies vehicles that are moving above a defined speed limit.



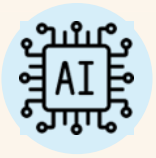
- **Risk of being trapped by something collapsing or overturning.** Forklifts are more likely to overturn if driven with a raised load or turning on an incline. Routes in the workplace should therefore avoid inclines.
- **Unstable items.** This is an important hazard, especially in warehouses.
- **Contact with moving machinery.** Designing a workplace that eliminates the need to approach moving machinery is the most effective control. CV can detect workers' movements in prohibited areas and differentiate between those who are authorised to access an area and those who are not.

- **Slips, trips and falls.** These account for around a third of all reported workplace injuries.[7] CV can detect when people stray from a designated pedestrian route and enter an area that may contain obstacles that could lead to a trip.

Figure 2: Technologies employed by the event recognition system

Computer vision

Analysis of visual inputs, such as CCTV feeds, using AI to recognise and identify objects, movements and interactions in an image. CV can be used to detect physical hazards and hazardous behaviours in the workplace.



Artificial intelligence

AI and deep learning techniques analyse the data using their capability to mimic human behaviour and enable a system to constantly improve its performance over time. They can thus achieve tasks the original programmer had not considered.

In addition to capturing unsafe events, the technologies embedded in the system can develop predictive models that help identify potential risks before they occur, allowing businesses to mitigate these risks and prevent accidents from happening.

2.2 Examples of use

Event recognition can prevent workplace accidents by anticipating potential workplace risks. Some of the sectors that could benefit using such a system include:

- **Logistics and supply chain:** Event recognition can help tackle risks such as forklift and truck collisions, regulate access to operational areas, prevent injuries from heavy lifting, pushing and pulling, and ensure that vehicles adhere to traffic signage.

[6] 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

[7] Health and Safety Executive. (n.d.). *Non-fatal injuries at work in Great Britain*. https://www.hse.gov.uk/statistics/causinj/index.htm

- **Ports and maritime:** Event recognition can play an important part in restricting access to operational areas, monitoring the speed of port-based vehicles and ensuring that port workers wear proper personal protective equipment (PPE).
- M**anufacturing and retail:** Event recognition can prevent machine-related injuries, injuries from heavy loads, non-compliance with PPE requirements and unauthorised access to restricted areas.
- **Waste management:** Event recognition can help prevent manual handling errors, monitor the proper usage of PPE by floor operatives, control the speed of factory floor-based vehicles and regulate access to operational areas.

Three real-world examples of the system's application across some of the sectors are mentioned below:

The **first example** is from a British retailer who implemented the event recognition system to improve workplace safety amid increased customer orders during the COVID-19 pandemic. Following the implementation of the system, the retailer monitored unsafe events and decided to review and improve its induction and training programme.

The **second example** is from one of Ireland's largest shipping conglomerates. There, event recognition revealed a significant risk emanating from the machinery utilised in port terminals, notably, large cranes. As a result, the shipping conglomerate launched a series of targeted campaigns aimed at mitigating incidents associated with crane operations.

The **third example** is from a leading building materials manufacturer with over 500 workers. In this case, event recognition was used to enhance workplace safety and operational efficiency. The system provided continuous visibility and custom rule-building flexibility, addressing specific requirements and enabling proactive risk identification. This led to improved safety measures, better communication and a reduced need for additional supervisors.

3 System implementation: drivers and barriers

3.1 Motivators and goals

The impetus for designing and developing the event recognition system for improved safety management was a fatal workplace accident that could have been avoided with preventive measures. This incident prompted the Irish manufacturer to create the event recognition tool. Implementing the tool requires the support and collaboration of an organisation's IT and Health and Safety departments. The IT departments handle the technical aspects of the system, while the Health and Safety departments are responsible for generating rules and evaluating the data provided by the system.

3.2 Drivers

The event recognition system is mainly implemented by large companies, mostly operating in the logistics, manufacturing, waste management and warehousing sectors. For many clients, the **integration of the system with their existing CCTV infrastructure was a key factor in choosing the system**. Next to this, however, there are additional factors facilitating the uptake of the system:

- ✓ customisation to client needs for safety improvement;
- ✓ interoperability of different tools and software;
- ✓ anonymised (occupational safety and health (OSH)) data;
- ✓ trial opportunities; and
- ✓ introduction of event recognition systems as an integral part of a comprehensive OSH framework.

Another driver for organisations to use this solution is the **onboarding process**, during which the product manufacturer supports and guides the clients' IT and surveillance teams to integrate their expertise successfully. The initial onboarding process demonstrates how the solution can begin to detect on-site events on average four to five weeks from the first day the system is turned on. Workers engagement and acceptance was recognised as a driver, given that the initial concerns in relation to data privacy, and feeling of constant monitoring are effectively addressed, while the purpose of the system installation is clearly communicated to all involved parties. Also, training is important, providing the perspective that this is a safety tool, which must always be its context. To that end, workers' involvement is a key issue to ensure effective system implementation. Finally, as Table 1 shows, the system's benefits for OSH management, OSH specialists and workers are additional drivers for the uptake of event recognition systems to improve safety management.

Table 1: Non-OSH benefits of the system as drivers for implementation

Role	Non-OSH benefits
Management	✓ Mitigate costly risks ✓ Data-driven insurance
OSH specialists	✓ 24/7 safety audits ✓ Configurable rules ✓ Video evidence
Workers	✓ Preserving personal privacy

3.3 Barriers

One of the main barriers to the effective implementation of event recognition for safety management is understanding what types of events should be captured and how to capture them. This requires **trained OSH and IT specialists** to recognise the most hazardous areas of their facilities given that they might not always be available in small to medium-sized organisations. In addition, such organisations might be lacking the **financial resources** to absorb the cost of implementing smart digital solutions or navigate the often **stringent national data privacy laws** of their countries.

As with any smart digital system that includes a monitoring function, **surveillance fears** can arise among workers. These fears are typically more pronounced when there **is lack of mutual trust between employers and workers**. Such concerns should be adequately addressed to ensure workers' acceptance and involvement that is needed for effective system use. Clear communication of the purpose for installing the system, technical measures that address any privacy concerns and establishment of a communication channel between the management and the workers were found as key factors to overcome such barriers. In addition, worker representatives and the unions could play a significant role on this making sure of the intended use. In addition, the product manufacturer reported that they always share relevant material with its clients (the employers) on 'rules to build trust using CCTV and CV systems'. This allows them to explain the system's functionality to the workforce, while training sessions for workers and demonstration of the system outputs further promote system acceptance. In all cases, the manufacturer highlights the role of management in building trust with workers (see box below).

Explaining the purpose of event recognition for safety management is key to building trust among workers. Any misunderstandings or misconceptions can be addressed by clearly conveying that the system focuses on preventing accidents in the workplace and not on monitoring performance or tracking workers' movements. When workers understand that the system is designed to improve their wellbeing, they are receptive to its integration into their daily work routines.

Finally, since the implementation of such an event recognition tool is not a legal requirement, it can be challenging to convince employers of its usefulness, with some considering it a non-returning investment. However, as more organisations adopt CV technologies, companies are beginning to recognise the direct and indirect cost benefits of CV's impact on reducing workplace accidents.

4 OSH impact

This section briefly presents the main opportunities and challenges associated with implementing event recognition for improved safety management in the workplace.

4.1 Opportunities

Event recognition enables real-time risk detection, helping OSH managers to promptly identify and address unsafe behaviours and risks. At the same time, it can forecast potential risks using predictive analytics and provide detailed insights into workplace safety trends.

The system can identify and provide early warning signals for a number of safety risks, such as **collisions with moving vehicles, risk of being trapped by something collapsing or overturning, unstable items, contact with moving machinery, or slips, trips and falls.**

Unlike human monitors, AI can operate continuously 24/7 without fatigue, ensuring constant vigilance over the workplace. In addition, the system provides uniform monitoring standards, reducing the variability that can come with human observers.

Data Analytics and Trend Identification allow informed decision making, as the insights gained can inform policy changes, training scheme, and resource allocation. OSH managers can leverage this information to understand recurring issues, assess the effectiveness of their existing safety and health measures, and foster a proactive approach to safety and health through, for example, **improving their induction and training programmes**, **redesigning their workspaces** and **introducing new safety protocols**. Such actions can increase workers' awareness and reduce the likelihood of unsafe behaviours and accidents, contributing to a safer work environment. For example, one of the companies that is using the system decided to launch a series of targeted campaigns aimed at mitigating incidents associated with crane operations, based on the fact that the event recognition system had identified significant risks. Furthermore, the system provides audit support, based on the documentation and evidence that safety measures are actively monitored and enforced.

4.2 Challenges

Event recognition systems for enhanced safety management can also present some challenges for OSH. One major concern is the potential negative psychosocial impact on workers, who may feel that they are being constantly monitored for performance evaluation rather than for safety improvement. This can lead to feelings of discomfort or anxiety, potentially affecting job satisfaction and morale. To address these issues, it is important to involve workers and their representatives in discussions about the system's purpose and benefits in terms of improving workplace safety, and ensure clear and transparent communication about how its data will be used.

Another challenge is the risk of over-reliance on technology. While event recognition systems can provide valuable insights into existing and potential hazards, they may lead safety officers to focus solely on risks highlighted by these systems, potentially neglecting other critical safety issues that are not captured by the technology. To address this, it is crucial to maintain a balance by ensuring human oversight and judgement remain key to the safety management process.

In large industrial plants, the increased screen time and cognitive workload that might be associated with these systems could also pose a challenge for OSH professionals and system operators. In particular, the constant monitoring of data from these systems could lead to information overload and fatigue. Also, it is worth noting that in the absence of pertinent training, there might also be a risk of misinterpreting these systems' data. To address these issues, it is important for product manufacturers to provide OSH professionals with comprehensive training and support, and to simplify the interface of their systems, with a strong emphasis on usability.

A cartoon-style representation of the system, including some of the challenges and opportunities for OSH, is presented in Figure 3.

Figure 3: Event recognition for improved safety management

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The rapidly evolving nature of CV technology presents an opportunity to establish more effective and proactive risk monitoring. Trained OSH/IT staff play a pivotal role in harnessing the system's capabilities and making optimal use of the valuable data it offers to anticipate risks and implement corrective actions. Nonetheless, this also poses a challenge for smaller companies that may lack the personnel to fulfil these roles within their organisation. In any case, workers' engagement and acceptance is crucial for effective system implementation, while data privacy should always be respected by the company as well as the intended system use.

5 Takeaways for development and implementation

This section outlines the primary insights for developing and safely implementing event recognition for enhanced safety management. Many of these insights are cross-cutting, as they apply to multiple cases analysed within EU-OSHA's research.

Takeaways for the development of event recognition for enhanced safety management. Product manufacturers/developers should:

- embed privacy by design – where feasible or preferred – into event recognition monitoring systems by incorporating features such as body blurring or ghosting;
- provide clear and transparent information to all involved actors, including the final users of the system and the workers, on how the systems works, what is its purpose, and the measures takes to ensure data protection and privacy, as workers involvement and acceptance is crucial for the system implementation;
- design systems that can integrate into organisations' existing systems to reduce migration costs;
- design dashboards with useful analytics that do not overwhelm OSH managers; and
- offer ongoing support to clients throughout the implementation phase.

Takeaways for the safe and healthy implementation of event recognition for enhanced safety management. Employers should:

- introduce event recognition systems as an integral part of a comprehensive OSH framework rather than as a substitute;
- act on the data insights to foster a proactive safety culture in the workplace; and
- engage workers and their representatives to address concerns regarding personal data collection, ensuring the intended system use;

- Establish a communication channel with workers that would allow effective feedback and enhance system understanding

List of abbreviations

AI	Artificial intelligence
AR	Augmented reality
CV	Computer vision
CCTV	Closed-circuit television
IoT	Internet of things
ML	Machine learning
OSH	Occupational safety and health
PPE	Personal protective equipment
VR	Virtual reality

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