1 Introduction

New OSH monitoring systems, like phone apps, wearables or smart glasses, hold promise to make workplaces safer. Especially in sectors with high-risks, such as warehousing, manufacturing, construction, mining, agriculture, and logistics, , but also in lesser-risk sectors, new OSH monitoring systems can track a wide cast of workplace risks and help workers and OSH professionals to manage them. Broadly, these systems can help prevent risks, or react to them. However, to present, there is still more to learn about these systems. It is important to understand how new OSH monitoring systems can be classified, what are their risks/challenges and opportunities across different sectors, and what does their future look like?

The workshop carried out on June 8, 2022, aimed at responding to these questions through presenting the research that is conducted by Ecorys for EU OSHA on new OSH monitoring systems for improving workers safety and health. The workshop presented a working taxonomy of these systems, their risks/challenges, and opportunities for OSH, as well as ways for employers to effectively integrate them into the workplaces. The workshop hosted a wide range of researchers, designers, employers', and employees' representatives who discussed and analysed in detail the present, and the future of new OSH monitoring systems.

New OSH monitoring systems is part of EU-OSHA's *OSH Overview* research project (2020 - 2023) aiming to provide in-depth information for policy, prevention and practice regarding the challenges and opportunities of digitalisation for OSH.

2 Introductory words by EU-OSHA

EU OSHA's executive director, **William Cockburn,** opened the session. William started by putting the project into context. He explained about EU-OSHA's earlier Foresight work that led to the *OSH Overview* umbrella project, which investigates the challenges and opportunities of digitalisation of OSH through different projects, including the one on digital systems for monitoring and improving OSH. These projects are listed below:

1. Advanced Robotics and AI-based systems for the automation of tasks
2. New forms of work management through AI-based systems
3. OSH and digital platform work
4. Digital systems for monitoring and improving OSH
5. Teleworking, remote work, and OSH

EU-OSHA will follow-up the work of these projects through its Healthy Workplaces campaign, starting from 2023-2025, attesting to the emphasis that the Agency places on new digital technologies on work and workplaces and the associated occupational safety and health (OSH) challenges and opportunities.

3 Findings from EU-OSHA research

Dr Dareen Toro, the Project Manager on behalf of Ecorys has set the scene through explaining why researching new OSH monitoring systems is topical and presenting the project's timeline and milestones. This was followed by other members of the team presenting different aspects of the research.

3.1 A definition & taxonomy for new OSH monitoring systems

Dr Monica Andriescu, Work Package 1 Leader, presented a definition and taxonomy for new OSH monitoring systems as well as an overview of the technologies that these systems are using.

- Given that OSH monitoring systems using digital technologies are relatively new, one of the first tasks of the research team was to come up with a short, clear, and balanced definition that is likely not to become obsolete in the near future. After a thorough literature review, the working definition was the following: **"New OSH monitoring systems use digital technology to collect and analyse data in order to identify and assess risks, prevent and / or minimise harm, and promote occupational safety and health"**

- New OSH monitoring systems use a wide cast of existing, but also new digital technologies. Less recent technologies **include Bluetooth, Radio Frequency Identification (RFID)** while new technologies

include **Artificial Intelligence, Machine Learning, Internet of Things, VR / AR and sensing-technology**

- Based on how OSH monitoring systems are using digital technologies, they can be broadly distinguished between **proactive** and **reactive**. This distinction serves as a useful analytical lens to research new OSH monitoring systems. However, it is not explicit, as in practice such systems can have multiple purposes, including both proactive and reactive

3.2 Challenges and opportunities of new OSH monitoring systems

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Mario Battaglini, Ecorys researcher, presented the opportunities of new OSH monitoring systems using the **proactive / reactive taxonomy**, and then gave an overview of the challenges that these systems can pose for workers.

Proactive new OSH monitoring systems:

- can **prevent or reduce risks**. In particular, technologies embedded in these systems can help identify a wide cast of workplace risks, including **physical, chemical, ergonomic, psycho-social, safety, etc.**
- can **perform remote-inspections** (e.g., drones) and thus prevent workers from getting involved in high-risk tasks in industries such as construction or mining
- can **provide on-the-job training**. In particular, these systems can nudge through vibration, sound or other types of alerts workers, when they are performing a task e.g., in a non-ergonomic way, and provide them with training that can be individualised based on the profile of the worker (e.g., height, weight, age, etc.)

Reactive new OSH monitoring systems:

- can **mitigate the consequences of accidents / emergencies**. For example, reactive new OSH monitoring systems using geolocation data can track workers that are at-risk and reduce the time of rescue operations
- can **help in accident reporting or investigation**

Although these two functions can promote OSH, there is a number of challenges around the use of new OSH monitoring systems at the workplace. These include:

- **Challenges around the use of data**. There are still questions regarding **the reliability / accuracy of data collection**. Do new OSH monitoring systems give us reliable data to act on? In addition, often there are questions around the potential **misuse of data** from employers for reasons not related to OSH, e.g., performance measurement. Last, but not least, questions around **privacy, ownership** as well as the **security of data** remain
- **Potential reverse effects**. While the introduction of new OSH monitoring systems might benefit a specific OSH aspect, it might have negative implications to another. Therefore, it is important to consider net effects. For example, an exoskeleton that re-distributes effort might limit certain biomechanical risks, but, at the same time, contribute to the emergence of new ones. By the same token, new OSH monitoring systems' **negative psychosocial implications to workers**, are also to be considered
- **Overreliance on new OSH monitoring systems**. Such an overreliance might have negative effects on OSH. It is important to note that new OSH monitoring systems are part of the solution, but not the solution in themselves. Such systems often have inherent limitations. However, even when these limitations are not substantial, new OSH monitoring systems alone are unlikely to bring systemic changes to OSH

3.3 Workplace resources

Kyrillos Spyridopoulos, Ecorys researcher, presented the workplace resources, e.g. company guidelines, procedures, as well as a series of enabling factors to effectively integrate new OSH monitoring systems at the workplace. Effective integration of new OSH monitoring systems relies also on the existing OSH structure and safety culture within companies. Companies placing emphasis on safety and have OSH professionals working close with workers on the site, are more likely to effectively integrate those systems. In practice, this often translates to clear steering from the OSH leadership, through company-level policies, a well-defined OSH management system, direct communication with workers, a mix of accessible and relatable workplace resources,

all of which are essential pieces of an OSH puzzle and can have a positive impact on the integration of OSH monitoring systems within an OSH management structure. The main points of the presentation are the following:

- Workplace resources at the international / national level can provide a bird's eye-view and help employers to design their own, individual approach to OSH. However, the majority of these resources does not make specific reference to new OSH monitoring systems. Instead, workplace resources from product manufacturers or employers are likely to cover these systems

- Workplace resources are useful but cannot in themselves help employers effectively integrate new OSH monitoring systems at the workplace. Therefore, employers should **maintain their OSH competencies based on the hierarchy of controls, nurture close collaboration of workers with OSH professionals on the ground and involve workers in every step of the process** (including testing, selecting, and optimising the new OSH monitoring system)

- Recommendations to effectively integrate new OSH monitoring systems include **cross-company or cross-sectoral peer-learning activities**, as well as **workplace resources that consider workers' needs and provide information around data, limitations, and rights, in an accessible fashion**

4   The experts' perspective: key messages

This session featured four experts discussing the challenges and opportunities of new OSH monitoring systems from the perspective of researchers, product manufacturers, as well as employees' and employers' organisations.

4.1   Egon van den Broek (Utrecht University): the researcher's perspective

In the context of OSH monitoring, it is important to explain the role of AI and data science. There are two types of AI:

- **Symbolic AI:** high-level, top-down, human-readable, rule-based representations using logic and knowledge representations.

- **Sub-symbolic AI:** low-level, bottom-up, learned representations. Currently, Deep Learning (DL), essentially a new, 3rd or 4th wave of Artificial Neural networks (ANN) is most prominent. DL has a much larger topology and is supported by much faster computing machinery than previous ANN.

Sub-symbolic AI is data-hungry, compared to the symbolic AI, which is based more on human knowledge and appears to become the dominant paradigm. Processing data of course, comes with a number of challenges on several fronts. These include:

- **data fusion:** it is important to understand how to handle incomplete and corrupted data and how to merge/integrate new types of data from different sources, such as interviews and questionnaires with video- and audio-based technologies.

- **security, big brother, & acceptance:** security issues can have a negative impact on the acceptance, constituting a social rather than technical risks. Workers may not feel secure if they perceive OSH monitoring systems as a "big brother".

- **persuasive tech:** OSH can also be used as an active system to behave in a proper and healthy way

- **a changing world:** a key challenge for OSH monitoring systems is to keep up with the rapid and constant changes occurring in the world.

- **Sense-making:** this is the biggest challenge. Modern OSH monitoring technologies, powered by new data and artificial intelligence, could provide customised OSH monitoring systems. However, how to make sense of and determine customised OSH monitoring systems remains complex.

Despite these challenges, new OSH monitoring systems bring a number of opportunities. Compared to traditional monitoring based on questionnaires (e.g., using 5-point Likert scales), interviews (e.g., using a chat bot); and blood samples (e.g., hormone levels), emerging OSH monitoring systems can rely on audio based (e.g., ASR), bio signals (e.g., electrocardiogram), vision based (e.g., facial expressions), text (e.g., Twitter messages) and interaction based (e.g., mouse and keyboard interaction, pressure sensors, GPS) technologies. In addition, such systems can cover multiple risks, ranging from metabolic issues (e.g., vitamin deficiencies and diabetes) and addictions (e.g., to games, social media and the Internet) to social isolation (e.g., resulting in depression). Finally, there is a question on the competency between human and AI – who is better? Although AI is currently close to the reliability results of the human intercoder, there is ambiguity about accountability in case of errors by AI. AI reliability is now roughly on pair with human coders. The problem is that if AI makes an error, who can be blamed?

Taking a cue from an epidemiological job coding, AI reliability (48%-80%) was very close to human intercoder reliability (44%-89%).

4.2   Jacqui McLaughlin (Reactec): the product manufacturer's perspective

- To effectively address OSH challenges, product manufacturers should **understand the employers' specific circumstances as well as their legal obligations**
- **Data can reduce workers' risk levels**. For example, with regard to vibration exposure, a leading utility company benefited from an extensive outreach and prevention programme halving the initial average exposure, i.e., from 14% to 7%

There are several **reasons explaining why OSH monitoring is not better adopted:**

- ISO standards lag technology by decades and put all the risk on product manufacturers to achieve change. Most of these ISO standards were written decades ago and lack recent concepts such as data collection. Consequently, people are reluctant to look at new technologies because the old ones have the standards.
- Data gathering could result in punitive consequences of gathering "guilty evidence".. This represents a barrier to employers looking to improve their employees risk environment. The employers are pushed back on "do I need to do it, or do I want to do it?"
- Many employers find that those who govern health & safety legislation are not in favour of monitoring technologies (for example, the risk of abuse of vulnerable people when data is not used for the right purpose).
- Those who govern health & safety legislation are restricted by reliance on standards which do not keep pace with technology

In terms of challenges, it is essential that employees **feel engaged and willing to participate** because there is an automatic fear of the data being collected. The technology must be easily adoptable, and employees must be able to see the benefits of monitoring. Finally, any monitoring system **must enjoy the trust of the employer and employee in the management of personal data. It is therefore important to ensure that the control and the access to these data is granted to both employers and employees**

4.3   Aída Ponce Del Castillo (ETUI): the workers organisation's perspective

- Monitoring/surveillance technology has been mostly available in the US, but now it is increasingly used in workplaces and, combined with algorithms, it is more powerful and intrusive as in the case of algorithmic management. However, in algorithmic management, algorithmic systems have to be performed in a co-governance setting and with stipulated in regulations.[1]

- During the pandemic, ETUI launched a survey where employers across the EU confirmed the use of data analytics for process improvement and/or monitoring employee performance. The use of data analytics could also be indicative of the use of algorithms to not only monitor but also assess employee performance. To conclude, "technological advances have certainly opened opportunities for employee monitoring and surveillance capabilities"

- ETUI research led to two findings:
    - worker monitoring -for different purposes- has increased without the technology being negotiated
    - the use of software, cameras and remote monitoring on workers has increased in the following countries: Austria Belgium, Italy, Germany, Norway, Spain, UK

- Experience from wearables in the market shows that several **apps have violated users' privacy by disclosing data to third parties** through software development kits (SDKs) incorporated into the wearable/app, despite the company's privacy policies. Another issue is that OSH monitoring systems can nudge good behaviour, however this is not always effective.

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[1] New Forms Of Worker Management Based On Artificial Intelligence (AI) And Their Implications For Occupational Safety And Health (OSH) - Virtual Workshop, 4 November 2021. For more information, see: https://osha.europa.eu/en/tools-and-resources/seminars/new-forms-worker-management-based-artificial-intelligence-ai-and-their-implications-occupational-safety-and-health-osh

- **The use of technology must respect the rules and principles of EU law** (i.e., GDPR, the e-Privacy Directive). Some advanced analytics (biometrics, semantic analysis, sentiment analysis, Emotion Sensing Technology, etc.), that monitor biology, behaviour and emotions might not be used lawfully according to the GDPR, and to the forthcoming AI Act (Chapter II, requirements for high-risk AI systems) and should not be put in the market

- **Some of the consequences and risks of these emerging OSH monitoring systems go beyond the OSH dimension.** There might be issue of discrimination since data collected from the worker may provide a comprehensive profile of worker characteristics, including health and personal information which possibly push the boundaries of the 'transparent employee'

- These challenges also represent an **opportunity to improve workers' data protection and the legitimate use of technology, enable workers to exercise their rights under GDPR, prevent psycho-social risks as well as negotiate collective agreements on data protection**

4.4 Kris De Meester (VBO FEB): the employers organisation's perspective

- What are defined as **new monitoring systems** (exoskeletons, radio-frequency identification devices) had already been **created/invented decades ago**. At the macro-level there are several changes **but at the company-levels things have not necessarily changed**, many company and workplaces are designed as they were 30 years ago

- Even if there is no visible change, there is a lot of discussion about the work organisation. Discussions over new monitoring systems should address one main topic: impact. Nobody wants to introduce a new OSH monitoring system which has no impact in improving the health and working environment. This is also the reason why after decades of unsuccessful monitoring it is important to answer the following question: 'monitor to do what?'

- Before addressing the challenges to improve the health and safety in the working environment, there is a need to create a digitalised organisation where people are able and willing to perform their best work. OSH cannot stand alone because otherwise it is not effective

- What is important is to give a tool for the health and safety of the workers. OSH monitoring systems should support workers and the main purpose is to reduce risks and hazards in the working environment. If these OSH monitoring systems are really implemented for the workers' safety, employers do not need to have the access to the data. It is important to have a tool for self-assessment/remote support. Last, the purpose of an OSH monitoring systems should be to assist workers and support organizational goals, not for political or controlling reasons

5 Q&A session

5.1 Ecorys and EU-OSHA

A short poll was carried out during the workshop where participants answered the following questions:

1. **Are OSH monitoring systems widespread in workplaces?** Overall, the answer was *'no'.*
2. **In your view are OSH monitoring systems expected to become widespread in workplaces?** Almost everyone answered *'yes'.*
3. **What do you considered to be the greatest challenges in relation to OSH monitoring systems?** *'Loss of control'* and '*loss of privacy'* were the key concerns among workshop participants.
4. **Would you personally consent to your health and safety being measured all time even outside the workplace?** The majority answered *'no'* but a relatively minority said *'yes'.*
5. **Does AI (e.g., analysing data, algorithm measuring etc) know better?** The majority of participants answered, *'not sure'* and a some said 'no'.

Workshop participants raised the risk of being too confident of these technologies highlighting the importance to maintain OSH professionals on the ground, using OSH monitoring systems as a **complementary tool**. It is important also to understand how **labour inspectorates** can assess the effectiveness of this OSH monitoring systems in preventing accidents and risks.

5.2 Main discussion points

Before starting the Q&A discussion on new OSH monitoring systems opportunities and challenges, workshop participants answered the following questions:

1. **Do you think that workers 'voice and participation is important when implementing new OSH monitoring systems?** All participants answered *'yes'*.

2. **Do you think that digitalisation will empower or overpower workers?** The majority of participants said *'empowering'*.

3. **Do you think the impact of digitalisation will be positive?** Participants mostly said '*yes*', but there are many also answered, *'not sure'*.

4. **Do you consider that cross-company or cross-sector dialogue could help integrate effectively new OSH monitoring systems at the workplace?** Most participants answered '*yes'.* No participants answered 'no'.

5. **What works best to help workers implement new OSH monitoring systems?** Participants mentioned '*institute trainings'* as well as '*video & posters'*.

The main points raised during the Q&A discussion were the following:

- **Technology appears to be running ahead of ethics** and in the case of OSH monitoring systems there is a need to build transparent ways to implement them. In this context, a continuing dialogue with employers and OSH professionals is essential.

- **Technology is running fast but not everything that is available is desirable, effective, or implementable.** It is important to understand which technologies are useful to address the specific challenges in different workplaces. **The same principle applies to data.** Collecting a large number of aggregate data, means that someone has to make sense of it. In this context, it is important not to only consider that data is available, but rather place emphasis on what such data are useful for.

- A good practice when integrating new OSH monitoring systems can be **involving works councils as well as social partners** in the process. For example, a product manufacturer noted that before introducing its new OSH monitoring system, testing at workstations has been discussed and agreed with works councils. The same product manufacturer stressed that it is important to have some **tangible data on the effectiveness** of new OSH monitoring systems to create confidence to C-level executives / decision-makers and proceed with a large-scale implementation.

- The surPASS project has been recently piloted in Denmark and aims to develop and evaluate an e-system for measuring daily physical behaviours (physical activity, sedentary behaviours, and sleep) at work and non-work time of working adults. This is a real-time monitoring of risk assessment. It turned out that the exposure time in critical postures was much lower than that assessed by the classical (digital or paper-based) assessment. This will most probably contribute to new insights such as objective and unobtrusive measurements as well as timely intervention that can be introduced to enhance compliance.

- **There is a need to redefine OSH purposes and limits.** There ought to be a definition of OSH's fundamental values. OSH is no longer just about being exposed to known risks, but also exposed to unknown risks.

- **There is a need to be clear about the purpose of new OSH monitoring systems.** Currently, some systems appear to go beyond OSH. For example, socio-metric tools performing sentiment analysis, which are frequently used nowadays in several workplaces (e.g., in call centres). There is uncertainty regarding how this technology can improve OSH and identify employees' performances. This could be seen as an invasive technology because it is not just tracking sentiment but creating psycho-social risks. In addition, OSH-approaches are sometimes designed based on data that has not been initially collected for such purposes.

There might be aspects of the working environment that can't be measured by new OSH monitoring systems. **New technologies should be considered also in light of their limitations.** In addition, when OSH monitoring systems are implemented in the workplace, they should analyse how workers and employers interact with each other

- One of the challenges is to understand **how workers can use data coming from their own devices to reduce risks and improve their health and safety conditions in the workplace**. Moreover, sometimes we put a lot of trust in new technologies, while we might forget to focus on signals coming from own bodies.

- Workplace resources are useful but not sufficient to manage and prevent risks. **Dialogue between employers and employees is essential at every step of the process**

6   Concluding notes

Prof. Phoebe Moore (University of Essex & the ILO) and **Dr Elsbeth de Korte** (TNO) presented some of the main key-take aways. These are the following:

- New OSH monitoring systems bring numerous opportunities for OSH. However, it is important to determine their scope, in order to avoid scope function creep[2]

- While thinking about the opportunities of new OSH monitoring systems, it is important to realise that these systems have limitations in terms of improving OSH and are not to be solely relied upon . These should support OSH management and not take over as human dialogue is crucial for safety.

- New OSH monitoring systems should not collect more data than necessary. When personal data is collected, it should have a clear link to OSH

- Working together with stakeholders (e.g., workers, OSH professionals) from the very beginning of new OSH monitoring systems (i.e., development phase) is essential to create systems that work. Co-creation techniques, through which stakeholders discuss what is important, and what is not, and set common goals, can help in this direction.

7   Closing remarks

Andrea Broughton, the Project Director on behalf of Ecorys, gave the floor to **Annick Starren**, the Project's Manager on behalf of EU-OSHA for the closing remarks. Annick, thanked everyone for their contributions, and called interested parties to follow the project and EU-OSHA's forthcoming Healthy Workplaces campaign.

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[2] "Function creep occurs when information is used for a purpose that is not the original specified purpose. For example, a workplace may install a security system that requires employees to sign-in or sign-out of the workplace. For more information, see: https://oipc.sk.ca/technology-and-function-creep-2/#:~:text=%E2%80%9CFunction%20creep%E2%80%9D%20occurs%20when%20information,sign%2Dout%20of%20the%20workplace.