ARTIFICIAL INTELLIGENCE FOR WORKER MANAGEMENT: RISKS AND OPPORTUNITIES

Building on its foresight work, in 2020 the European Agency for Safety and Health at Work (EU-OSHA) initiated a four-year research programme on digitalisation and occupational safety and health (OSH). The aim of this programme was to support evidence-based policy-making by providing deeper insights into the consequences of digitalisation on workers' health, safety and wellbeing and how these are addressed at the research, policy and practice levels, as well as by describing examples of successful practices.

Complementing the findings presented in EU-OSHA (2022a), this policy brief presents OSH risks and opportunities of artificial intelligence (AI)-based worker management (AIWM) systems, which are extensively discussed in EU-OSHA (2022b), and proposes a number of recommendations. A separate policy brief (EU-OSHA, 2022c) focuses on the prevention measures and related recommendations.

AIWM is an umbrella term that refers to a worker management system that gathers data, often in real time, on the workspace, workers, the work they do and the (digital) tools they use for their work, which is then fed into an AI-based model that makes automated or semi-automated decisions or provides information for decision-makers on worker management-related questions (EU-OSHA, 2019; European Commission, 2021; European Parliamentary Research Service, 2020; High-Level Expert Group on Artificial Intelligence, 2019). It is one of the recent developments in the workplace that presents opportunities but also risks and challenges for workers' safety and health.

Risks for workers' health and safety

Intensification of work

The intensification of work is one of the most frequently reported risks related to the use of AIWM systems. To increase productivity, organisations might implement AIWM systems that direct workers to work without mini-breaks, minimise the time for certain procedures and force them to work at high speed. A common example of the intensification of work due to AIWM can be found in warehouse operations: to speed up work, AIWM is used for tracking order completion time as well as workers' movements, mistakes and breaks, in order to eliminate 'unnecessary'" time lags. Such systems are also employed in white collar jobs. For example, Barclays, a bank based in the United Kingdom, uses tracking software in some of its offices to monitor the time workers spend at their desks or the length of their toilet breaks, informing the workers when their breaks are deemed by the algorithm to be too long, which results in increased work intensity (Eurofound, 2020; European Parliamentary Research Service, 2020).

Loss of job control and autonomy

Loss of job control and autonomy are also commonly reported risks related to the use of AIWM systems in the workplace: some AIWM systems can take over the control of work (e.g. content, pace, schedule) through, for example, worker direction, and little will be left to be decided by the worker (Curchod et al., 2020; Kellogg et al., 2020; Saithibvongsa & Yu, 2018). Also, most algorithmic and AI-based systems dictate how to perform work or tasks to the worker and this can result in a loss of control over their work (Curchod et al., 2020; Kellogg et al., 2020). The loss of job control and autonomy is frequently associated with high levels of stress, and also leads to lower productivity, poor performance and increased levels of sickness absence (HSE, 2017). According to Karasek's (1979) job demands-control model, 'high-strain' jobs, where employees have high demands at work and at the same time very little control over what they do at work, have the highest negative impact on mental health. High demands and low control hinder a worker's capacity to choose the method and time frame to complete a job, yet require a high number of cognitive resources, which can lead to mental health problems.

Dehumanisation of workers

Active use of AIWM systems, such as through excessive worker direction, evaluation or discipline, might also lead to dehumanising workers and, in the long run, force them to behave as machines (Carr, 2014;

Danaher, 2018; EU-OSHA, 2018; Heaven, 2020), which could then, based on several interviewed experts in the field, lead to decreased cognitive and intellectual capacities, decrease of creative thinking, a loss of autonomy, shortness of independence of thought and so on. It is worth noting that while AIWM systems are expected to be able to inform workers and employers about risks (e.g. probability of fatigue and burnout), they might also lead to dehumanisation of workers as they might become dependent on the warning system created by AI and possibly lose their own ability to recognise hazards once something goes wrong. In turn, this might lead to ill health or work-related accidents.

'Datafication' of workers

It can also be argued that by introducing automation and AI-based technologies, organisations might start to see workers as mere objects or collections of 'objective' digital data that they produce while working (De Stefano, 2018), while at the same time removing margins of manoeuvre from workers, or even controlling their emotions. This dehumanisation can be referred to as the *'datafication'* of workers (Gal et al., 2020; Mai, 2016) – treating workers as collections of digital data. Although datafication is used for the digitalisation of different aspects of work and tracking in real time, analysing and predicting workers' behaviour (Subedi & Pradhananga, 2021), the quantification of human life through data is controversial and may serve only economic purposes and can discriminate against individuals (Eubanks, 2017).

Worker discrimination and use of private and sensitive data

Usage of AIWM systems can also result in worker discrimination, as intrusive monitoring can involve collecting private and sensitive data (Ravid et al., 2020), which can in turn be used to make automated or semi-automated decisions about the worker. This can result in favouring certain workers and discriminating against others, for example, at the stages of hiring or appraising/promoting workers. Even though AIWM systems may offer accuracy when looking at the desired profile of candidates in a selection process, they may make assumptions on candidates based on their characteristics (for example, gender, ethnicity, nationality, age, sexual orientation, gender identity) and then make decisions resulting in some form of worker discrimination (Fernández-Martínez & Fernández, 2020; EU-OSHA, 2018), especially when AIWM systems are designed incorporating a bias. Discrimination is recognised as a main stress factor at work, and it is related to mental health issues.

Performance monitoring and impact on workers

AIWM can also force workers to work faster through constant monitoring, including monitoring the actions they perform and their productivity. When workers are aware that they are constantly monitored and their performance is evaluated, they may refuse to take breaks when needed and they might also neglect social interactions with other peers (EU-OSHA, 2018) in order to catch up with the schedule or follow the directions provided by the AIWM system. For example, when Disney Resorts introduced an electronic leader board with a traffic light theme that tracked the performance of laundry staff, workers were struggling to keep up and started skipping bathroom breaks. The workers referred to the leader board as 'the electronic whip' (Lewis, 2019). Such systems that create a complete overview of one's performance that is visible to peers may also result in an unhealthy competitive environment between colleagues. In turn, this kind of pressure can lead to anxiety and low self-esteem in workers (EU-OSHA, 2018).

Worker rating systems

Performance pressure might also be exacerbated by, according to Wood and Lehdonvirta (2021), customer satisfaction rating systems that lead to customer algorithmic empowering. More specifically, AIWM can use customers' rankings to penalise workers, ignoring possible biases in the opinions of customers, and leading to insecurity among workers (Frey & Osborne, 2013; Lee et al., 2015). These issues might be further exacerbated if there is no transparency from the managers on how workers are rated, as well as if workers are unable to contest these ratings and evaluations.

Risky and unsafe worker behaviours

If performance pressure is created by AIWM, for example, through algorithmic direction that increases the speed of work, or through evaluation algorithms that rate workers and force them to work more, this creates a tendency for risky or unsafe behaviours as workers may need to choose between following directions and being productive or staying safe and healthy. For example, workers may decide to remove the safety guard of a machine in order to complete the work procedure in a shorter amount of

time or take a faster or more dangerous route to deliver goods to the consumer. Excessive control can also lead to a low safety culture as workers start to favour productivity over safety, as well as have less time to communicate with their peers and thereby transfer their OSH knowledge (EU-OSHA, 2018).

Repetitive movements, awkward postures and ergonomic issues

The push to work faster can also lead to a higher number of repetitive movements, awkward postures due to rushing, and less attention paid to a worker's body and limb position and ergonomics. The repetitive movements that involve the same muscle groups, a fast pace and high quantity of work are especially hazardous, as the worker has no time to recover in the short periods of time between the motions. In the long run, the body needs more effort to perform the task and recovery time becomes even more important. Hence, the faster the pace, the less time is available for recovery, and the higher the risk for musculoskeletal disorders (MSDs) (Descatha et al., 2020; Finneran & O'Sullivan, 2010). In addition, intense work can result in high levels of work-related stress, fatigue, exhaustion and burnout (EU-OSHA, 2018).

Worker reskilling and deskilling

In addition, according to EU-OSHA (2018), some tasks taken over by new technology may lead to situations where workers' initiative, concentration and skills are not required and jobs may lose meaning, and thus result in decreased job satisfaction. Interviewed experts also stressed the issues of reskilling and deskilling of the workforce because of AIWM, which may lead to a high level of work-related stress, increased levels of boredom and lower job satisfaction (CWA, 2017; Mishra et al., 2019). The study of an Italian Amazon warehouse reveals that algorithmic direction dispossesses workers of essential and required knowledge for performing their work tasks (Delfanti, 2019). In addition, fast technological change may require workers to learn new skills (Ra et al., 2019) and, even, may lead to skills-displacing technological change, which can be defined as 'technological change that may render workers' skills obsolete' (McGuinness et al., 2019, p. 3). Related to AIWM, this implies that some systems, such as those that direct workers, might lead to workers losing some of their skills.

Worker loneliness and social isolation

Extensive usage of AIWM by an organisation can also make workers feel lonely and isolated. This is because such systems often force workers to communicate less with their peers by forcing them to work more and focus on productivity. In turn, due to the lack of communication between workers, and a lack of social support, the environment is not encouraging for camaraderie and no close work community is formed (Bérastégui, 2021). This, in turn, may lead to fierce competition among employees and thus endanger cooperation and team spirit and the working climate more generally. These problems can increase work-related stress and, initially, may also cause workplace bullying and mobbing (O'Moore & Lynch, 2007). In turn, feelings of loneliness and isolation can lead to depression (Cacioppo et al., 2006), anxiety (EU-OSHA, 2019), and can even decrease people's capacity for reasoning and decision-making (Murthy, 2017). Working in isolation can also decrease one's professional identity – employees lack role models or mentors and therefore cannot establish a consistent and strong professional identity (Bérastégui, 2021). In addition, Hawkley et al. (2010) showed that if the effect of loneliness accumulates, it can increase systolic blood pressure. Finally, loss of support from managers/supervisors in cases where AIWM systems replace them might lead to increased stress, anxiety and, in some cases, burnout in workers (Bérastégui, 2021). This is because supervisors play a key role in providing support to workers, as well as rewards and resource allocation (Jabagi et al., 2020), which often serves to mitigate the negative effects of high-strain jobs (Bérastégui, 2021).

Lack of transparency and trust

The lack of transparency about how AIWM systems operate is a frequently reported issue. Namely, many scholars and interviewed experts argue that worker monitoring, or usage of AIWM systems, is not usually implemented in a transparent way in organisations. Most managers and workers do not know how AIWM systems work, while some workers may not even be aware of being controlled or monitored by AI-based systems. Therefore, employees must be trained and clearly informed about the functioning of the AIWM systems and what data is collected and why, as well as be able to trust their employers to implement AIWM systems for good reasons, and this requires transparency within the organisation and proper worker consultation and participation. However, according to interviewed experts, many organisations are not truly transparent about what kind of data they collect and how it is used. This lack of transparency is reportedly related to informational asymmetries (Gregory, 2021;

Rosenblat & Stark, 2016; Shapiro, 2018; Veen et al., 2020), which provide an advantage only to those who hold full information.

Resisting algorithmic management

Usage of AIWM might also lead to workers resisting algorithmic management, which might lead to animosity and lack of trust between workers and employers, in turn leading to negative psychosocial effects. For example, Lee et al. (2015) studied Uber and Lyft platform drivers and their motivation to follow algorithmic directions and algorithmically assigned work and found that they did not always obey the rules. Workers found several reasons to manipulate the system, for example, briefly turning it off to avoid long trips or dangerous neighbourhoods, or staying tuned in when needing a break, and parking in-between other ride sharing cars in order to get the hourly payment promotion, while not getting a ride request at the same time. This, in turn, might lead to stress and anxiety in workers if an algorithm would interpret such actions as negative and punish workers as a consequence. Though the example refers to platform work, similar issues can apply in all organisations where AIWM tracks and dictates how workers should perform their work.

Power asymmetry

AIWM systems are also reported to deeply alter the industrial relations within an organisation (Aloisi & Gramano, 2019). For instance, the heavily competitive culture that AIWM systems might create through, for example, gamification can prevent workers from teaming up and can lead to the deterioration of organising and negotiating power (Eurofound, 2020). Similarly, heavy worker monitoring that allows employers to collect sensitive data on workers further shifts some power from workers to employers. The power asymmetry can trigger feelings of anxiety and vulnerability in workers (Curchod et al., 2020). A recent study by Tomprou and Lee (2022), focusing on how algorithmic management may affect the relationship between employer and employees with a focus on psychological contracts and employees' perceptions of their own and their employers' obligations, sheds some light on this. For example, the study demonstrates that the way in which employees form and evaluate their psychological contracts with an algorithmic (versus human) agent depends on inducements. Inducements refers to different types of motivations for workers, such as salary, personal support, development opportunities, etc. Based on Tomprou and Lee (2022), potential employees perceived greater employer commitments to uphold inducements mentioned during recruitment if this was done by a human agent rather than algorithmically. Though, employees also exhibited higher turnover intention when the human agents under-delivered as compared to the algorithmic agents as they trust the former more than the latter.

Malfunctioning and consequences for workers

The aforementioned risks can be further exacerbated if AIWM malfunctions through data input or analysis problems, inaccuracies with systems and other software problems (Brione, 2020; EU-OSHA, 2019). For example, if an AIWM tool directs workers towards a hazardous situation, it can lead to severe physical harm and, in some cases, even death. This issue is especially prevalent in the manufacturing sectors and warehouse-centric work where accidents between vehicles and humans can occur. Malfunctioning AIWM systems can also have a negative psychological effect as workers might feel frustrated and/or confused when they do not get clear and sufficient responses to their questions and relevant information, for instance, on how to perform tasks, or when communication and the distribution of tasks within an organisation is organised and managed by using automatic response systems and AI-based systems (Todoli-Signes, 2021).

Opportunities for workers' health and safety

Risks monitoring

One way in which AIWM might improve OSH is through improving monitoring of the workplace, the workers and the work they do by analysing, in real time, human behaviour and work patterns. This can be used to improve OSH risks monitoring (Min et al., 2019). For example, AIWM tools that direct workers on how to perform their tasks might also monitor their posture to identify if it is inappropriate and if it poses MSD risks (Katwala, 2017). This can be done by, for example, using a framework developed by Alwasel et al. (2017) that allows to identify whether workers are working in a productive way without jeopardising their health through unsafe poses. One expert also mentioned that such systems can be used to identify whether or not a worker who is working with dangerous equipment is concentrated on the work tasks being carried out, as mistakes due to distractions or lack of concentration could lead to

injuries. Other scholars (Aliabadi et al., 2014; Ciullo et al., 2019; Iida et al., 2021) have also acknowledged the advantages of AIWM systems as a supportive tool for OSH experts and occupational health doctors, for example, by providing data and analyses for the diagnoses of work-related, or even occupational, diseases. AI can also be used to detect if a worker is wearing the right protective gear, thus reducing the risk of accidents and health disorders. For example, AIWM can detect if a worker is working at a designated height without taking adequate safety precautions (e.g. harness equipment) and warn them about this, as well as send an alarm to the control centre (Palazon et al., 2013).

Mental health monitoring and digital counselling

Enhanced monitoring through AIWM systems can also allow for workers' mental health monitoring, for example, by assessing workers' psychological distress levels, as revealed in a Japanese study (Doki et al., 2021) and in an Italian–Mexican study (Hernandez-Leal et al., 2015), or estimating the probabilities for different psychosocial issues (e.g. burnout) (Oracle and Workplace Intelligence, 2020; Zel & Kongar, 2020). For example, AIWM can be used to accurately, and in real time, identify stress in workers through their writing and speech patterns (Lu et al., 2012; Rachuri et al., 2010). AIWM can also be employed to detect burnout and exhaustion in workers and would therefore allow for prevention measures. Additionally, AIWM systems that can listen in on workers talking and that are able to analyse this information can identify and detect cases of bullying or sexual harassment. The same can apply to AIWM that can perform speech or text (e.g. content of emails) analysis. For example, Sanchez-Medina et al. (2020) described an AI-based tool that can explore and analyse relationships between certain personality traits (e.g. psychopathy) and potential sexual cyberbullying behaviours. Another way to use AIWM for improving workers' mental health is through digital counselling. Given that the good mental health of workers, which leads to higher productivity, recently became an important goal for many organisations, some of them started to experiment with AI-based mental health chatbots (Cameron et al., 2017; Oracle and Workplace Intelligence, 2020).

Worker engagement and satisfaction

An AIWM system might also be used to promote employee engagement and satisfaction (Hughes et al., 2019). For example, AIWM systems that are less focused on heavy worker control but more on supporting workers (e.g. AI-powered worker collaboration systems that improve communication between workers and help to identify people with relevant skills who can help on a job) may facilitate engagement, as it might give more freedom to workers (Hughes et al., 2019). Gamification technologies that reward workers for their job performance might also improve engagement (Hughes et al., 2019). Similarly, AI-powered chatbots and virtual assistants that workers can use to get relevant human resources (HR) or work-related information can also help with improving worker satisfaction (Galin & Meshcheryakov, 2020; Zel & Kongar, 2020).

Personalising workstations and work routines

In addition, AI-based systems can also be used to personalise workstations and work routines based on workers' needs to create a better match between the worker and the work tasks, for instance, tailoring them for disabled or ageing workers (Segkouli et al., 2021; Soter Analytics, 2020). Herzog and Harih (2020) proposed an AI-based decision support system that identifies/categorises workers with disabilities and then selects the most suitable work routines or physical workplaces according to the requirements for disabled workers. Finally, personalised work planning and scheduling could also take into account workers' health (e.g. fatigue levels) in order to assign easier work to those who are overworked (Brione, 2020; Tursunbayeva, 2019).

Designing healthy and safe jobs and workplaces

By collecting data from the workplace, AIWM systems can also be of support in designing and implementing safety training programmes for workers or can be used to inform the development of the most appropriate health and safety strategies, as stated by the interviewed experts. In addition, AIWM systems can be used to better plan and design activities, tasks and workers' schedules in order to minimise risks. This can allow employers to monitor, minimise and control workers' exposure to psychosocial risks and to hazards such as chemicals, noise, vibration and others. Additionally, AIWM systems can provide individual risk-related profiles for workers based on their health surveillance on possible health risks, their current risk level, and the likelihood of future health risk by, for instance, analysing and identifying which workers are more sensitive and susceptible to specific hazards, such as noise, high/low temperatures and similar (Chamorro-Premuzic, 2020; EU-OSHA, 2018).

Recommendations

In order to address the risks related to the implementation of AIWM systems in the workplace, a number of recommendations for better prevention of OSH risks stemming from the use of AI systems to manage workers, and to make the most of them in terms of OSH improvements, can be formulated.

Recommendation 1: AIWM systems need to be based on a human-centred approach

AIWM systems must be designed, implemented and managed to be safe and transparent, guaranteeing workers' consultation, participation and equal access to information at all stages, and making sure that humans are in command at any time. To ensure this, close and effective dialogue between workers and employers and collaboration between researchers, developers, industry, social partners and governments on research and innovation in designing AIWM is needed and should be actively pursued.

Recommendation 2: Risk assessment must be tailored to AIWM systems

Given the novelty of AIWM, risk assessment must cover all of the work-related factors, and it should be carried out together with specialists in the programming of algorithms in order to address and to consider the existence of uncertainties and ascertained risks. In this regard, it seems necessary to develop standardised technical procedures for the risk assessment of AI-based systems based on sufficient scientific endorsement. The analysis should also follow a holistic approach, in order to address the possible risks of AIWM on OSH at different levels, such as at the specific job, organisation, sector, region or country. In addition, given that AIWM systems are able to evolve and self-learn, the assessments of such systems should be carried out periodically.

Recommendation 3: Raising awareness and sharing knowledge on AIWM systems

Raising awareness and sharing knowledge on AIWM systems usage and the related implications for OSH among employers, HR departments, workers and their representatives, OSH actors including labour inspectorates, and AIWM systems developers is of utmost importance. There is a clear need to provide training for managers and workers about AIWM systems, focusing on how these can affect OSH and how to prevent related risks. Upskilling and reskilling efforts should go beyond simply giving technical knowledge to workers and they should focus on providing workers with sound awareness, knowledge and understanding of how AI works and how to safely work alongside it, and foreseeing how AI can change employees' tasks and roles at work, as well as the impact of AI on their health and career. Education efforts should also not solely focus on workers but also on trade unions, employers and their confederations, and developers of AI-based systems. Regarding support systems, workers should have the means to request and get support on different issues related to AIWM and its possible effects on OSH.

Recommendation 4: Developing an EU-level ethical framework

Interviewed experts also emphasised the need for the development of an EU-level ethical framework that would dictate how AIWM, and AI-based systems in general, can be used in the workplace. At the same time, many experts agree that ethical frameworks alone will not be sufficient, and compliance with existing legal provisions applicable to AIWM (such as OSH legislation, the General Data Protection Regulation, or GDPR, forthcoming Artificial Intelligence Act and anti-discrimination law) should be ensured.

A number of additional recommendations relate more directly to the research and knowledge gaps that were identified. Overall, it is worth highlighting that in order to reduce and manage risks and make the most of the opportunities for OSH stemming from AIWM systems, it is crucial to rely on robust and evidence-based research, which will allow to design and implement informed interventions at workplace level and also policy and regulations at national or even EU levels. Research specifically focusing on the effects of AIWM on OSH, especially that based on empirical evidence, is rather limited, and a number of gaps and research needs exist, as pointed out by interviewed experts but also in relevant academic literature (e.g. European Commission, 2013; Kagermann et al., 2013).

Recommendation 5: Conducting interdisciplinary and holistic research on AIWM and OSH

More interdisciplinary and holistic research on how AIWM might affect OSH should be undertaken. The holistic approach should include, but should not be limited to, analysing how AIWM might affect OSH in general terms, how negative effects of OSH can be mitigated through a transparent and ethical design, development, implementation and analysis of AIWM systems, how to ensure that AIWM

systems do not collect data on workers beyond what is needed for their functioning, how to help workers exercise their legal rights to prevent such systems from collecting unnecessary private information and how to help them to challenge the recommendations and decisions made by such systems, how to mitigate the negative effects of AIWM on OSH at the development stage, and more.

Recommendation 6: Include the human-in-command approach in the research on AIWM

Research should focus on identifying to what extent humans are kept in command and AIWM systems are used to support workers rather than replace them and that their deployment does not lead to OSH risks. More focused research would allow to improve existing regulations, which have many drawbacks, including not being based on social dialogue, seldom covering workers, not including a strong accountability clause of who is to blame when AIWM systems lead to harm, and more, by ensuring that workers are always kept at the centre of them, as stated by several interviewed experts and the literature (e.g. De Stefano, 2021; Ponce del Castillo, 2021).

Recommendation 7: Consider how business management models and AIWM interact

More research is needed to understand whether existing business management models are sufficient to prevent and manage the OSH risks that AIWM might bring. As the adoption of an AIWM system often requires changes to the business management model, it is not 'a given' that the interaction between the AIWM system and the existing business management model will not lead to OSH risks. Because of this, research should focus on evaluating if currently used business models are compatible with AIWM systems and if they will not lead to negative OSH effects. If research shows lack of compatibility, it is then important to develop new models that will ensure workers' health, safety and wellbeing when AIWM systems are introduced.

Recommendation 8: Pursuing knowledge sharing between researchers and AIWM developers

More knowledge sharing between researchers and developers of AIWM systems is needed. Given that AI-based systems rely heavily on programming and also often rely on big data, in order to ensure transparency, replicability and that such systems do not lead to harm, it is crucial that the developers of AIWM systems share all relevant information with the research community at large (including also the policy and OSH communities, and other relevant stakeholders). This will allow researchers to design and carry out more accurate and informed research about how such systems might affect OSH, which could be of help in designing risk assessment tools, prevention measures, policies and regulatory initiatives.

Recommendation 9: Research on AIWM systems and OSH should be carried out on a continuous basis

Analysis to determine whether AIWM systems continue to be safe should be carried out periodically. Given that AI-based systems are able to learn from the environment and evolve, it is incorrect to assume that they are stable and not changing (Dahlin, 2021). This means that research efforts on how AIWM affects OSH should not only be carried out once at the development or integration stage of AIWM systems. An evaluation/analysis should be carried out periodically to ensure that AIWM systems that were previously deemed safe are still harmless to workers.

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