European Agency for Safety and Health at Work

Digital technologies at work and psychosocial risks: evidence and implications for occupational safety and health

Report

European Agency for Safety and Health at Work

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Executive summary

This report provides a comprehensive analysis of the implications of digitalisation for occupational safety and health (OSH) regarding psychosocial risk factors based on the findings of EU-OSHA publications. Drawing from over one hundred documents, including reports, policy briefs, discussion papers, case studies and results from the OSH Pulse survey 2022, the report outlines how digital technologies can result in work-related psychosocial risks and mental health issues. The analysis is broken down by type of technology and tasks that the technology is able to perform. The report presents the analysis of implications of digitalisation in terms of psychosocial risks according to the five key areas identified in EU-OSHA's research programme on OSH and digitalisation (2020-2023): advanced robotics and artificial intelligence (AI), smart digital systems, digital platform work, remote working technologies and artificial intelligence for worker management (AIWM).

Key findings

- ### Advanced robotics and artificial intelligence

Advanced robotics and AI are defined as intelligent machines that collect, analyse data and make decisions. These systems are prevalent in sectors such as healthcare, education, customer support, marketing and financial advice, including mobile robots, assembly robots and exoskeleton robots. Although currently limited in use – 5% of OSH Pulse survey respondents use AI machines and 3% use cobots – the potential future spread of these technologies highlights the importance of understanding the related OSH risks. Advanced robotics and artificial intelligence can bring many opportunities, as they are able to perform tasks more efficiently, with higher precision and endurance, and offer humans safer conditions by taking over the more dangerous tasks. This allows for more time for learning and creativity among workers and reduces their exposure to hazardous environments. AI and data analytics can also be used to improve efficiency of OSH inspections (EU-OSHA, 2019d). However, the introduction of such technologies can also present some risks for the worker, which can be physical, organisational and psychosocial (EU-OSHA, 2022a; EU-OSHA, 2019c).

Cognitive overload, the most frequently reported risk across all case studies carried out in this area, is primarily associated with the adoption of technologies that automate cognitive tasks, leading to concerns about increased cognitive demands on workers due to the need to monitor and interact with complex systems. It may lead to stress and decreased job satisfaction. Companies are addressing this risk by implementing comprehensive training, clear communication and social support structures. Another significant risk is the **fear of job loss** or **job insecurity** which is linked to depression, anxiety and emotional exhaustion. Preventing this risk encompasses involving workers in the implementation process, clear communication from management, and providing psychological support services. **Lack of trust** can lead to 'automation complacency' or misuse of the technology. Building trust requires transparency about the capabilities and limitations of robotics systems, gradual introduction of technology, reskilling and feedback mechanisms. **Deskilling and/or the need for upskilling/reskilling** occur as automation shifts roles from manual tasks to monitoring systems, causing stress and uncertainty. Finally, **changes in job content** occur as automation shifts roles from manual tasks to monitoring systems, causing stress and uncertainty. Companies are addressing this through training, worker engagement and open communication for feedback and adjustments.

- ### Smart digital systems

Smart digital systems encompass a range of technologies including sensor-based devices, AI, the internet of things (IoT), wearables, wireless technologies, augmented and virtual reality (AR/VR) and drones. EU-OSHA's literature on smart digital systems highlights both challenges and opportunities deriving from the adoption of such technologies. Among the opportunities we find that smart digital systems can prevent and minimise harm to workers, improve OSH compliance, help in achieving informed decision-making and can provide more training opportunities in virtual environments.

In this area, several psychosocial risks stand out: for instance, **lack of trust** between workers and employers can arise from digital surveillance, leading to concerns around the invasion of privacy and the gathering and use of personal data. Addressing these concerns necessitates clear communication about data usage, security and privacy protections. **Workload increase and time pressure** are also significant risks, as smart systems often raise productivity expectations, resulting in stress and time

pressure for workers. These systems might also reduce workers' **autonomy** by dictating work pace and methods, leading to demotivation and decreased job satisfaction. **Poor communication** and **poor social relationships** have also been mentioned in several case studies, as technology reduces face-to-face interactions, negatively affecting workplace cohesion and mental health. A sense of **unfairness** may develop if the technology is perceived as invasive or biased, particularly with algorithmic management lacking transparency. Finally, inadequate training on new technologies can leave workers feeling unprepared and anxious, exacerbating stress and dissatisfaction. Mitigation strategies to address these risk factors include ensuring data privacy, worker involvement in decision-making, enhanced human accountability in data interpretation, and adapting legal and policy frameworks.

- **Digital platform work**

Digital platform work – defined as all paid labour mediated through online platforms – is characterised by non-standard working arrangements, algorithmic management, involvement of third parties and a shift of risks and responsibilities to workers. Digital platform work can bring benefits such as increased autonomy, more flexible working hours and better work-life balance. However, it is also associated with many challenges, especially because both algorithmic management and non-standard working arrangements can lead to psychosocial risks. Algorithmic management (i.e., the use of technological tools for remote workforce management, relying on data collection and surveillance to enable automated decision-making) creates high control on workers and their work, and how they are monitored, therefore reducing **job autonomy** and increasing **performance pressure**; at the same time, the presence of non-standard working arrangements means that platform workers are generally classified as self-employed (even though the situation is beginning to change), and therefore not covered by standard OSH legislation in most EU countries.

EU-OSHA's case studies on this topic examine OSH risks for four categories of platform workers: low-skilled on-location (e.g., parcel delivery), high-skilled on-location (e.g., handiwork), low-skilled online (e.g., content moderation), and high-skilled online (e.g., programming). Their analysis reveals that some psychosocial risk factors are common to all forms of platform work, while others are specific to some types of tasks. Common risk factors include **professional isolation**, **workload increase** and time pressure, job and income insecurity, lack of autonomy, and a sense of unfairness and lack of trust due to non-transparent algorithmic management.

Certain psychosocial risk factors are unique to specific tasks, for instance low-skilled online work, like content moderation, involves **exposure to distressing content**, which can lead to psychological trauma, stress and mental health problems. High-skilled online work, such as programming, is associated with **cognitive overload** due to intense mental focus. **Poor work-life balance** is especially pronounced in online work, exacerbated by the global nature of platform demand. **Physical health risks** are more prevalent in on-location work, with potential accidents and exposure to hazards during parcel delivery and handiwork. On-location workers may also face **violence, harassment**, and exposure to crime, particularly taxi drivers or delivery riders.

EU-OSHA's research on the platform economy highlights that the self-employed status of platform workers shifts the OSH risk management burden from the company onto workers. The reports propose expanding current OSH regulations to protect platform workers, irrespective of employment status. Proposed solutions include the provision of insurance, training, ergonomic practices, measures for professional isolation and work-life balance, task performance guidance and regular risk assessments by the companies. Facilitating collective bargaining and representation is also crucial to address job and income insecurity.

- **Remote working**

Remote working offers flexibility and autonomy, potentially increasing productivity and can benefit workers with chronic conditions by allowing better management of health and fatigue. However, the use of remote working technologies can also give rise to several psychosocial risk factors, including work-life balance issues, feelings of isolation, constant connectivity leading to increased workloads, reduced autonomy and poor social relationships.

One of the most frequently mentioned psychosocial risk factors brought about by the mass shift to telework after COVID-19 is the **blurring of work-life boundaries**. Indeed, the home environment, traditionally a personal space, became a workspace for many while often lacking the ergonomic features

of an office. The convenience of working from home has meant many continue to work even when unwell, and not taking the sick leave they are entitled to. In addition, the pressure to remain constantly connected and respond to emails outside working hours has led to work extending into evenings and weekends.

Feelings of **isolation and poor social communication** are also widespread among teleworkers. The lack of informal, spontaneous interactions that typically occur in office environments can lead to a sense of disconnection from colleagues and the **organisation**. **Reduced work autonomy** is another concern – monitoring tools, such as time tracking software and more intrusive technologies that log keystrokes and monitor communications, can feel invasive and diminish workers' sense of autonomy.

Finally, gender-specific impacts are significant. Women often face higher **work-life conflict** and stress levels due to the blurring boundaries between work and private life, intensified by their care responsibilities. Reports indicate that women who telework experience more severe time pressure, work overload and worse mental health outcomes compared to their male counterparts. Additionally, the increase in domestic violence during the pandemic has further complicated the situation for many women, who may have considered their workplace as one of the few safe spaces.

- **Artificial intelligence for worker management (AIWM)**

Artificial Intelligence systems for Worker Management (AIWM) collect real-time data from the workspace, workers and their activities. These data are processed by AI systems to make automated or semi-automated decisions or to provide information to decision-makers such as HR managers and employers. The use of AIWM can present significant benefits, such as improved scheduling and task allocation, optimised work organisation, and provide better information to identify OSH issues; however, it may also lead to psychosocial risks.

According to EU-OSHA's literature, AIWM systems in workplaces are associated with **time pressure, increased workload, cognitive overload, fear of job loss**, and stress due to continuous surveillance. The lack of transparency in AIWM systems and the opaque nature of automated decisions can foster **lack of trust** and a sense of **unfairness** among employees. Additionally, the reduction in work autonomy and the need for constant adaptation to new technologies contribute to cognitive overload and job dissatisfaction. Suggested solutions focus on transparency, worker participation in the implementation phase, worker feedback and rules to prevent work from invading private life. Reskilling and upskilling initiatives are also recommended to counteract the fear of job loss and perceived lack of training.

The main psychosocial risk factors identified for each technological area and the proposed preventive strategies are summarised in the table below.

Psychosocial risks related to the use of digital technology and proposed solutions

Technology area	Main psychosocial risk factors identified	Proposed solutions
Advanced robotics and AI	Cognitive overload, fear of job loss/job insecurity, lack of trust, deskilling/need for upskilling, changes in job content.	Comprehensive training and upskilling programs, worker involvement in planning and implementation, clear communication, ergonomic adjustments, psychological support.
Smart digital systems	Lack of trust, workload increase and time pressure, poor communication and social relationships, sense of unfairness, lack of training.	Clear communication about data usage, security, and privacy protections, involving workers in implementation, ergonomic considerations.
Digital platform work	Professional isolation, workload increase and time pressure, job and income insecurity, lack of autonomy, sense of unfairness and lack of trust, exposure to distressing content, cognitive overload, poor work-life balance.	Extending OSH obligations to platform workers, multi-level governance involving local authorities and worker organisations, transparent algorithmic management, collective risk assessments, training and ergonomic support.
Remote working technologies	Poor work-life balance, increased workload/extended working hours, isolation/poor social communication, lack of autonomy.	Comprehensive teleworking agreements, ergonomic support and necessary equipment, involvement of social partners, clear communication, the right to disconnect.
AI for worker management (AIWM)	Time pressure, poor communication, fear of job loss, workload increase/work intensification, cognitive overload, poor work-life balance, lack of trust/sense of unfairness, lack of autonomy, worker deskilling/lack of training.	Transparency in data use, participatory approach, specific rules to prevent work from spilling into private life, reskilling and upskilling initiatives.

Source: author's elaboration

Policy pointers and good practices

EU-OSHA's literature on digitalisation and OSH underlines the importance of several key practices for an effective management of the psychosocial risks associated with the introduction of new digital technologies, particularly in the context of AI, advanced robotics and remote working technologies.

According to the reviewed literature, existing legislation does not fully address the new challenges introduced by digitalisation. While current regulations, such as the European Framework Directive 89/391/EEC on Safety and Health of Workers at Work and 'daughter' directives, and directives on working time and work-life balance, are generally applicable, they do not specifically address the impacts of these new technologies. For this reason, it is vital to integrate emerging risks related to digitalisation into OSH strategies, including the provision of specific guidance on risk prevention in relation to the directives. To this end, it is necessary to involve a wide range of stakeholders, including workers and their organisations, to ensure that strategies on digitalisation and work comprehensively address psychosocial risks, resulting in more robust and responsive OSH policies. On the other hand, OSH needs to be embedded in directives, national legislation and stakeholder agreements on digitalisation when they are developed.

Organisations need to implement robust policies that guarantee adequate training, clear communication and supportive management practices. These measures are crucial not only for mitigating the negative effects of digitalisation but also for promoting a healthier, more secure and productive working

environment. Case studies show that companies offering comprehensive training programmes and involving workers in decision-making processes achieve better adaptation to new technologies and successfully prevent psychosocial risks, such as cognitive overload and job insecurity, and their impacts in terms of mental health. Legislators are encouraged to support education systems and training programmes specifically designed to address the psychosocial risk factors associated with new digital technologies.

The importance of **training and upskilling** is frequently cited across the case studies. Providing comprehensive training sessions ensures that workers are well-prepared to handle new equipment and processes. This approach not only improves their skills, but also boosts their confidence, significantly reducing stress related to potential job displacement. For instance, the successful implementation of collaborative robots in a Portuguese case and the AI-based systems in a German case was largely due to the extensive training and involvement of workers, which facilitated smoother transitions and greater acceptance of new technologies.

Worker involvement and engagement are also highlighted as crucial elements to increase trust and reduce fear of job loss. This approach fosters a sense of ownership among workers and helps identify potential issues early on, allowing for a more seamless integration of new technologies. Policy case studies reveal that in both Portugal and Germany, the feedback and active participation of workers were integral to the successful deployment of AI and robotics.

Clear and open communication is essential for managing the psychological risks associated with the introduction of AI and advanced robotics. It is vital to inform workers what the technological changes entail, including operational changes, new safety protocols and procedures for emergency situations. Clearly outlining how these changes will affect individual roles and what workers can expect helps to reduce fears and build trust between management and workers.

Regular workload assessments and consequent adjustments are necessary to maintain a healthy work environment by ensuring tasks are distributed fairly and workers are not overburdened so as to prevent excessive pressure and cognitive overload. Promoting flexible work arrangements to foster better work-life balance for workers is essential in managing the psychosocial risks associated with digital technologies.

Finally, given the widespread issue of poor work-life balance, which is associated with telework, platform work and AIWM technologies, ensuring the **right to disconnect** is crucial for preventing worker stress and burnout.

It should also be remembered that while digitalisation poses significant risks, it holds the potential to improve working conditions, particularly for vulnerable workers. By ensuring that new technologies are designed and implemented with the needs of all workers in mind, organisations can create more inclusive and supportive work environments.

1 Introduction

This report presents the results from a comprehensive review of over a hundred documents published by the European Agency for Safety and Health at Work (EU-OSHA) on the topic of digitalisation and its implications for Occupational Safety and Health (OSH), including scientific reports, discussion papers, policy briefs and case studies, with the aim of identifying and discussing the psychosocial risks factors most frequently associated with the digitalisation of the work processes according to this previous research. In addition, the review provides some context with headline statistics drawn from the OSH Pulse survey of workers, commissioned by EU-OSHA at the beginning of 2022, as well as EU-OSHA's 2019 European Survey of Enterprises on New and Emerging Risks (ESENER).

The review begins by examining two key reports from EU-OSHA: the 'Foresight on new and emerging occupational safety and health risks associated with digitalisation by 2025' (EU-OSHA, 2018a) and 'Digitalisation and Occupational Safety and Health' (EU-OSHA, 2019a), from which it draws an implicit definition of **digitalisation** as **the process of integrating digital technologies into all aspects of human society, profoundly transforming how we work, communicate and ensure safety and health in workplaces**. The definition of digitalisation heavily relies on the technologies it encompasses, such as Artificial Intelligence (AI), advanced robotics, widespread connectivity and remote working technologies, the internet of things (IoT), big data, wearables, mobile devices and online platforms that can be found in all sectors of the economy and society. Given this, the analysis of the impact of digitalisation on psychosocial risks in section 3 will focus on these specific technologies.

The introduction of digital technologies can improve working conditions and reduce occupational risks; for instance, advanced robotics can improve OSH by removing people from dangerous jobs and reducing exposure to physical, chemical and ergonomic risks. AI systems can carry out mundane and routine service tasks, tasks which can cause stress, overwork, musculoskeletal disorders and boredom from their repetitive nature. Similarly, wearable devices can allow for proactive management of OSH risks by providing real-time data on environmental conditions, worker posture and other critical factors.

At the same time, digitalisation poses new challenges by changing the dynamics of work. For instance, smart robots may increase the risk of accidents and put performance pressure on workers; pervasive digital monitoring enabled by artificial intelligence can negatively affect workers' mental health due to feeling of loss of control over work, invasion of privacy and increased insecurity and stress. In addition, digitalisation brings about new forms of work organisation, such as flexible and remote working arrangements. While flexible work arrangements can have positive effects and improve work-life balance, they can also lead to irregular working hours, increased demands for permanent availability and the blurring of work-life boundaries. Finally, the increased use of robots and intelligent machines in the workplace, along with remote working arrangements, can reduce opportunities for social interaction and support among colleagues and therefore lead to increased social isolation. To mitigate these risks, EU-OSHA literature underscores the importance of governance, regulation, ethical frameworks and workplace measures, ensuring that technological advancements are implemented in a way that protects workers' safety and health by taking a human-centred approach in design and implementation. It stresses the need for a collaborative approach involving policymakers, researchers, industry stakeholders and workers to develop strategies that reduce the risks while maximising the benefits of digital technologies.

Understanding the impact of digitalisation on psychosocial risks is crucial to guide employers and policymakers in creating safer, more supportive work environments amid technological change. The rapid pace of technological advances brings new challenges to OSH and the necessity to update and revise existing regulations to remain effective. In addition, by understanding the specific risks associated with digitalisation, organisations can put in place more effective preventive measures, to benefit workers' wellbeing, while maintaining productivity and job satisfaction. Finally, addressing psychosocial risks is essential for creating inclusive and sustainable work environments where all workers can thrive. This is particularly important as the workforce becomes more diverse and digital technologies become more pervasive (EU-OSHA, 2021j; EU-OSHA, 2018b).

2 Digitalisation and psychosocial risks: definitions and empirical evidence

Addressing psychosocial risk factors at work is crucial as they can result in physical and mental health issues for a worker: they are associated with health problems such as depression and anxiety, but also heart disease and musculoskeletal disorders. In addition, psychosocial risks are concerning from an employer's perspective, as they can lead to increased absenteeism, lower productivity and financial losses.

The European Framework Directive 89/391/EEC on Safety and Health of Workers at Work, transposed into Member State legislation, requires employers to assess risks and bring in prevention measures. The directive covers all risks, including psychosocial risks. Employers are required to adapt the work to the individual, especially as regards the design of workplaces, the choice of work equipment and the choice of working and production methods, with a view, in particular, to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health. They are also required to adapt to technical progress. Consultation with workers and their representatives is a general requirement, but there is also a specific consultation requirement regarding the planning and introduction of new technologies, as regards the consequences of the choice of equipment, the working conditions and the working environment for the safety and health of workers. By directly involving workers in organisational decision-making, many of the OSH measures adopted to prevent psychosocial risks act by shifting the locus of control in favour of the workers, which, according to established literature, moderates the relationship between performance monitoring and stress (Kolb and Aiello, 1996). The provision of adequate training is another general requirement, and especially when any new technology is introduced.

The literature has shown that advancements in technology could lead to an increased prevalence of psychosocial risks across various sectors of the economy (Leka, Jain, Widerszal-Bazyl, Widerszal-Bazyl, & Zwetsloot, 2011). Findings from a recent report co-authored by EU-OSHA, the JRC and Eurofound (Urzì Brancati, Curtarelli, Riso, & Baiocco, 2022) also highlight the relationship between advanced digital technologies and the presence of psychosocial risks in the workplace. Directive 90/270/EEC on display screen equipment requires software to be suitable.

2.1 Defining psychosocial risks

This section describes the psychosocial risks associated with digitalisation, beginning with their definition based on EU-OSHA literature: **psychosocial risk factors are the aspects of the design and management of work, and its social and organisational contexts, that have the potential to cause psychological or physical harm to the worker**. Psychosocial risk factors include time pressure, fear of job loss, poor communication, lack of autonomy, excessive workload and others detailed in **Error! R eference source not found.** below.

Table 1: Main psychosocial risks and potential mental health impact

Psychosocial risk	Description and related mental health outcome
Fear of job loss /job insecurity/financial insecurity	Job and income insecurity are major work-related stressors and have been associated with poor mental health, burnout, depression, anxiety and physical health issues such as fatigue and pain.
Long or irregular working hours	Prolonged working hours or irregularity of working schedule can lead to fatigue, which is a significant health outcome.
Time pressure	Increases stress levels and can lead to rushed decisions and mistakes, compromising safety and health.
Excessive workload	Can lead to stress, burnout, and physical health problems due to sustained high levels of effort.
Monotonous work (work underload)	Can cause mental disengagement, reducing vigilance and increasing the risk of accidents.
Cognitive overload	Occurs when the amount of information-processing required exceeds the cognitive capacity of the individual; this may lead to decreased performance, increased stress and potential errors.
Poor communication or cooperation within the organisation	Creates confusion, misunderstandings and conflicts, affecting mental wellbeing and productivity.
Lack of involvement in making decisions that affect the worker	Reduces job satisfaction, increases stress, and can lead to decreased motivation and engagement.
Lack of autonomy and lack of control over one's work	Lack of autonomy or lack of influence over how the job is done, an important source of stress that negatively affects mental health, especially when coupled with high demand/time pressure/excessive workload.
Third-party violence (threats, abuse, assaults from members of the public): having to deal with difficult customers, patients, pupils, etc. and cyberviolence	Exposes workers to emotional strain and potential conflict, increasing stress levels. Exposure to abuse can directly affect mental and physical health, leading to stress, anxiety and long-term psychological harm.
Poor social relationships within the workplace, including harassment, cyberharassment, cyberbullying and sexual harassment	Can lead to isolation, decreased job satisfaction and mental health issues like depression and anxiety.
Conflicting demands and lack of role clarity	Cause stress and uncertainty, making it difficult for workers to prioritise tasks and manage their workload effectively.
Lack of support from management or colleagues	Leaves workers feeling undervalued and isolated, which can exacerbate stress and negatively affect mental health.
Sense of unfairness/discrimination	Undermines trust in the organisation and can lead to disengagement, stress and mental health issues.
Lack of adequate skills / lack of training	Leads to a lack of confidence and competence in performing job tasks, increasing stress and the risk of errors.

Psychosocial risk	Description and related mental health outcome
Lack of trust	Lack of trust erodes the foundation of positive workplace relationships, leading to increased scepticism, reduced cooperation among workers and higher stress levels. This ultimately affects overall organisational effectiveness and employee wellbeing. Trust issues can also concern lack of trust in the technology, which may lead to over-reliance on it on one side and under-utilisation on the other.
Change of job roles	Change of job roles can be seen as a psychosocial risk as it may involve new skills that workers have not yet acquired and lack of adequate support and training; in addition, when the new role is perceived as less skilled or prestigious, it can lead to feelings of undervaluation or an identity crisis. Stress is more likely if workers are not informed or involved in the change process.
Exposure to physical hazards at work	Working in the presence of physical hazards can be stressful. While work-related stress exacerbates the risk of musculoskeletal injuries, or working at a fast pace can lead to a higher risk of accidents and injuries.

Source: author's elaboration based on EU-OSHA's literature

2.2 Empirical evidence from OSH Pulse and ESENER surveys

OSH Pulse headline findings

Findings from EU-OSHA's OSH Pulse survey (2022) of workers suggest that a fairly large proportion of workers are experiencing mental health problems: in particular, 37% of survey respondents claim to suffer from overall fatigue, while 27% suffers from stress, anxiety or depression.

The survey also includes questions ascertaining whether the workers are exposed to selected psychosocial risks in the workplace.

- Severe time pressure or work overload: mentioned by 46% of respondents;
- Poor communication or cooperation within their organisation: mentioned by 26% of respondents;
- Lack of autonomy, or lack of influence over the pace of work or work processes: mentioned by 18% of respondents;
- Violence or verbal abuse from customers, patients, pupils, etc.: mentioned by 16% of respondents; and
- Harassment or bullying at work: mentioned by 7% of respondents.

To investigate the impact of digitalisation, the OSH Pulse survey asked respondents about their use at work of digital devices such as: desktop computers, laptops, tablets, smartphones or other portable computer devices; wearable devices (e.g., smart watches, smart glasses, activity trackers or other (embedded) sensors); broadband technology to access the Internet; machines or robots that can think and make decisions, often known as artificial intelligence (AI); robots that interact with you (cobots).

A subsequent study on mental health at work (EU-OSHA, 2024) based on OSH Pulse data found that only 12% of respondents did not use any digital device for their work, and that the main digital technologies used are computers, smart phones and other portable devices. The study also investigated how digital devices were used in the workplace: 30% of respondents replied that they were used to allocate tasks, working time or shifts; 27% replied that their performance was rated by others, such as customers, colleagues or patients through digital technologies; a quarter replied that it was used to directly monitor their work or behaviour; over half (52%) answered that the use of digital technologies in their workplace determined the speed or pace of their work.

The study suggests that the use of digital devices is associated with an increase in exposure to psychosocial risk factors. In particular, one in three respondents (33%) replied that these technologies increased their workload; over four in ten respondents (44%) said that digital technology results in them

working alone; just under four in ten (37%) that the use of digital technologies increased the surveillance of them at work; and finally, 19% of respondents said that the use of digital technologies reduced their autonomy at work.

Finally, according to the study, the analysis of the OSH Pulse survey also suggests that workers who use digital technologies (basic and advanced) are more likely to report poor mental health at work than those who do not use any digital devices.

Digital work was also associated with an increase in work-related stress as a result of the COVID-19 pandemic. While the differences were not pronounced, it was highest for those working, for example, with computers, laptops and the internet (45.4% compared to 41.1% for those whose work did not involve digitalisation). While it is not possible to identify any causal links between digitalisation and an increase in work-related stress during the pandemic, we do know, for example, that many workers had to start using new software for communication, or suddenly change to delivering their services online (teachers being a particular example, as well as client-facing public services).

Exposure to psychosocial risk factors related to the use of digitalisation (increased workload, reduced autonomy) showed somewhat weaker associations with poor reported work-related mental health, although they were statistically significant and point to the importance of decent digital work for mental wellbeing. Also, those reporting that the use of digital technologies increased their workload or reduced their work autonomy were more likely to report that work stress increased due to the pandemic than those who answered no to either of these factors.

ESENER 2019: Headline findings

EU-OSHA's European Survey of Enterprises on New and Emerging Risks (ESENER) provides a different insight into the presence of psychosocial risks in workplaces. In the ESENER survey, the respondents are the enterprises (owner, a manager or a health and safety representative) not individual workers.

The overview report on ESENER 2019 (EU-OSHA, 2022o) includes an analysis of the following psychosocial risk factors:

- Having to deal with difficult customers, patients, pupils etc.: mentioned by approximately 59% of EU27 establishments;
- Pressure due to time constraints: mentioned by approximately 45% of EU27 establishments;
- Having to work long or irregular hours: mentioned by 22% of EU27 establishments;
- Poor communication or cooperation within the organisation: mentioned by approximately 18% of EU27 establishments; and
- Fear of job loss/job insecurity: mentioned by approximately 11% of EU27 establishments.

As we can see, time pressure is one of the most common psychosocial risk factors according to both the OSH Pulse and ESENER surveys. It is likely that digitalisation may exacerbate this problem, for instance by enabling constant connectivity or setting the time or pace to carry out a task. When it comes to the most common psychosocial risk factors according to ESENER, that is, having to deal with difficult customers patient and pupils, digital technology may, in principle, both provide some respite by replacing the most problematic interactions, or worsen it, by taking over easy interactions and leaving the most problematic ones to human workers.

It is interesting to notice how poor communication in the workplace is perceived to be a problem by a larger proportion of respondents when workers are interviewed, whereas it is mentioned by a slightly smaller share of establishment representatives.

It should be mentioned that the list of psychosocial risks included in ESENER and the OSH Pulse survey is not exhaustive, and that many more are cited across the report.

3 How different digital technologies influence the presence of psychosocial risks in the workplace

The concept of digitalisation is fundamentally tied to the technologies that define it, so this section examines the specific technologies that are central to it, focusing on how they transform the workplace and may give rise to a number of psychosocial risks.

The next sections will summarise findings from EU-OSHA's literature on the impact of digitalisation on psychosocial risks. The analysis is structured around the five topic areas identified in 'EU-OSHA OSH overview' research programme (2020-2023)[1], which include: 1) advanced robotics and artificial intelligence (AI); 2) smart digital systems; 3) digital platform work; 4) remote working; and 5) artificial intelligence for worker management.

3.1 Advanced robotics and artificial intelligence

According to EU-OSHA's literature, AI-based systems are intelligent machines that collect and analyse data to make predictions and decisions so that they can achieve specific goals. AI-based systems are very versatile and widespread across different sectors: healthcare and medical diagnosis, education or elderly care, customer support (chatbots), as well as marketing, business analytics or financial advice. Advanced robotics (encompassed in AI-based systems) can be described as sophisticated systems capable of performing complex tasks either autonomously or working alongside humans. Some examples are mobile robots, assembly robots and exoskeleton robots.

Findings from the OSH Pulse survey reveal that the use of advanced robotics and AI in the workplace is still not very widespread compared to other technologies (i.e., personal computers), since approximately 5% of respondents report using machines or robots incorporating AI, while only 3% uses robots interacting with the worker (cobots). The findings are very similar to what is reported by Eurostat's ICT survey (Urzì Brancati, Curtarelli, Riso, & Baiocco, 2022), however, since the technologies are expected to spread further in the future, also as a result of incorporating more advanced technologies into the 'older' ones (e.g., AI in personal computers or tablets), understanding the potential risks they carry is crucial.

The advantages of adopting such technologies in a work setting are well-known: advanced robotics systems are able to perform tasks more efficiently, with higher precision and endurance, and offer humans safer conditions by taking over the more dangerous tasks. AI and data analytics can also be used to improve efficiency of OSH inspections (EU-OSHA, 2019d). However, the introduction of such technologies can also present risks to workers, which can be physical, organisational and psychosocial (EU-OSHA, 2022a; EU-OSHA, 2019c). For instance, the introduction of advanced robotic systems may create ergonomic problems if humans and robots share a space not designed for humans, who may therefore have to work in awkward or uncomfortable positions; sharing a space with a robot may also increase the risk of accidents and collisions. From an organisational perspective, the introduction of advanced robotics and AI can affect communication, cybersecurity and upskilling/reskilling practices. Finally, the introduction of advanced robotics and AI systems can give rise to a number of psychosocial risks, including fear of job loss, increased workload, lack of trust, loss of autonomy, loss of privacy and increased isolation.

EU-OSHA has published three main reports on the OSH impact of advanced robotics and artificial intelligence, namely 'Advanced robotics and automation: implications for occupational safety and health' (EU-OSHA, 2022a), 'Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health' (EU-OSHA, 2022b), and 'Cognitive automation: implications for occupational safety and health' (EU-OSHA, 2022c). EU-OSHA also published 11 policy briefs (EU-OSHA, 2022e; EU-OSHA, 2023bb; EU-OSHA, 2022d; EU-OSHA, 2023a; EU-OSHA, 2023cc; EU-OSHA, 2023ff; EU-OSHA, 2023hh; EU-OSHA, 2022w; EU-OSHA, 2022k; EU-OSHA, 2022cc) and 16 case studies on the topic, whose findings will be discussed in the next sections.

[1] https://osha.europa.eu/en/themes/digitalisation-work

- **Observed psychosocial risks from in-depth case study analysis**

As part of its research on advanced robotic and AI-based systems for the automation of tasks and OSH, EU-OSHA conducted 16 case studies in workplaces that have adopted these technologies (for a short summary see Appendix 1, EU-OSHA 2023a to EU-OSHA 2023p).

The case studies reveal a consistent pattern of psychosocial risks arising from the integration of advanced robotics and AI in the workplace across various industries. Below, we outline the main risks identified, highlighting the solutions implemented.

Cognitive overload: cognitive overload emerges as a significant psychosocial risk associated with the integration of advanced robotics and artificial intelligence (AI) in various workplaces. This risk, mentioned in five case studies (Case 1, 3, 4, 7, 9 in Appendix 1), is identified in sectors ranging from manufacturing and automotive to healthcare, demonstrating a broad impact across different industries. Cognitive overload is primarily associated with the adoption of technologies that automate cognitive tasks, leading to concerns about increased cognitive demands on workers due to the need to monitor and interact with complex systems. The case study analysis points out that the risk can lead to increased stress, anxiety and decreased job satisfaction, affecting worker wellbeing and productivity.

The companies that mentioned cognitive overload also reported having put in place prevention measures such as worker training and involvement, clear communication and documentation, and the provision of social support. Worker programmes may include simulations, hands-on sessions and continuous learning opportunities to keep pace with technological advancements, so that workers would be able to confidently handle new technologies and workflows. Another fundamental step to address cognitive overload is to involve workers in the implementation process and seek their feedback, for instance, with regular meetings, suggestion boxes and feedback sessions that allow workers to voice concerns, suggest improvements and contribute to the design of workflows. Also important is the adoption of clear communication strategies and documentation to provide details on operational procedures, safety protocols and troubleshooting steps. Finally, companies provided psychological support structures, such as counselling.

Fear of job loss/job insecurity: Feelings of job insecurity or the fear of job loss due to the introduction of advanced digital technologies frequently emerge in the EU-OSHA literature. They are linked to mental health outcomes such as depression, anxiety, emotional exhaustion and a general decrease in life satisfaction. An analysis of the 16 case studies reveals that fear of job loss is mentioned fairly often – i.e., in 5 case studies (Case 1, 3, 4, 7, 10 in Appendix 1) – and that it is associated with both cognitive and physical tasks. The policy brief 'Automating cognitive tasks in the workplace using AI-based systems: cases and recommendations' (EU-OSHA, 2023a) acknowledges the ongoing fear of job loss associated with automation, but highlights some new insights regarding AI-based automation of cognitive tasks. In particular, it points out that AI-based systems without physical embodiments (e.g., software applications) seem to trigger less intense fears of job loss compared to those used alongside physical devices, like robotic arms. AI systems without physical embodiments often assist rather than replace the workers' primary tasks, therefore workers benefit from a reduction in workload while their job roles remain largely unchanged.

Companies addressed job loss fear through worker involvement and communication strategies; managers often intervened to reassure on job security. Providing psychological support services, such as counselling, and building acceptance and trust in new technology were also important factors.

Lack of trust: Trust plays a crucial role in any workplace and especially when it comes to the introduction of new technologies. The policy brief 'Advanced Robotics and Automation: Key Considerations for Human Interaction and Trust' (EU-OSHA, 2022e) stresses the importance of designing human-robot interactions that promote a healthy level of trust to improve safety and efficiency. Indeed, the report explains that too much trust can lead to what is called 'automation complacency', with workers over-relying on the technology, and therefore neglecting their duties or overlooking the probability of making errors. By contrast, too little trust may result in misuse, disuse or abuse, of the technology. Another fundamental element in building trust mentioned in the policy brief (EU-OSHA, 2022e) is transparency about the capability and limitations of robotics systems, which helps manage workers' expectations and promotes an understanding of the technology. The challenge is to strike the right balance so to avoid overwhelming users.

Lack of trust is explicitly mentioned in two case studies (Case 5 and 12 in Appendix 1). In both cases, the technology (cobots) is introduced in factories to replace physical repetitive tasks, with workers showing initial resistance and in some cases second-guessing the technology and interfering with its programming. A gradual introduction of the technology is considered crucial for creating trust and acceptance among workers. In addition, companies implemented reskilling and training of workers, feedback systems and biometric doors and barriers to reduce unauthorised interactions.

Deskilling and need for upskilling/reskilling: Deskilling and the need for upskilling/reskilling arises primarily in the context of the transition from manual tasks to operating advanced technologies. It is mentioned in three case studies (Case 3, 4, 7 in Appendix 1). This risk factor is associated with changes in job content and structure, whereby the automation of tasks requires workers to acquire new skills so as to adapt to technological advancements. Generally, workers' craftsmanship is replaced by the robot and their new roles require them to operate the technology, therefore involving a higher cognitive effort.

The solutions mainly focused on reskilling and training workers to operate new technologies, ensuring they could transition smoothly to the new roles. In addition, implementing the cobot technology in stages allowed workers to slowly adapt to the changes and helped ease any initial resistance towards the new technology.

Changes in job content: This risk is mentioned in two case studies (Case 2 and 4 in Appendix 1) and it is linked to the automation of cognitive and physical tasks, where the role of workers shifts from manual or routine cognitive tasks to roles that require monitoring, troubleshooting or interacting with automated systems. This transition can be a significant source of stress and uncertainty for workers due to the fear of inadequacy in meeting new job demands or of losing value or importance as a resource in the workplace.

Among the solutions set up to deal with the change in job content due to automation, companies mentioned training/upskilling and reskilling of workers, along with worker engagement and involvement. In addition, open communication for feedback and adjustments helped improve job satisfaction and adaptation to changes in job content and structure.

The report 'Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health' (EU-OSHA, 2022b) also explores the automation of tasks and provides a taxonomy of tasks based on:

- Technology integration: backend (algorithms, processing and decision-making capabilities of robotics systems) versus frontend (interaction interfaces between robots and human workers, devices etc.);
- Degree of automation: assistance versus substitution;
- Nature of the task: physical versus cognitive tasks.

The policy brief 'Automating cognitive tasks in the workplace using AI-based systems: cases and recommendations' (EU-OSHA, 2023a) discusses the potential impact of the automation of cognitive tasks in the workplace, with an emphasis on psychosocial risks, based on the analysis of three case studies.

The 16 case studies on the impact of Advanced Robotics and Artificial Intelligence are particularly useful, as they explicitly mention the types of tasks affected. In more than half of the case studies, the technology replaced or assisted with physical tasks, while in four case studies the technology replaced a combination of cognitive and physical tasks.

An analysis of the case studies shows that the introduction of these technologies into the workplace does not have a uniform effect on psychosocial risks, but varies significantly with the nature of the task performed, be it cognitive, physical, routine, complex (non-routine) or a combination. For instance, when the technology performs physical tasks, it introduces safety risks related to direct interaction with machinery. In contrast, cognitive and combined tasks raise concerns about performance pressure and the need for mental adaptation to new systems, highlighting the mental strain and adjustment required beyond physical safety.

The main psychosocial risk factors mentioned when the technology was introduced into the workplace, with the aim of assisting with or replacing cognitive routine tasks, were cognitive overload from monotonous monitoring or data analysis and fear of job loss. Solutions include training and education

to manage cognitive overload and worker involvement in the deployment of the technology to mitigate fears of job losses.

For cognitive non-routine (complex) tasks, the main psychosocial risk factors mentioned were the need for upskilling or reskilling – as these tasks necessitate additional training, performance pressure to match AI efficiency – especially in roles requiring high skill levels, and finally lack of trust and resistance towards the technology. Solutions for these risk factors involved upskilling programs, clear communication about the technology's role and limitation, and social support to address performance pressure.

The psychosocial risk factors associated with the introduction of technologies assisting with/replacing physical routine tasks include physical safety risks and concerns about deskilling due to the automation of manual specialised tasks. Addressing these concerns involves comprehensive safety training, ergonomic considerations and a gradual introduction of technology to ease the transition.

In the case of physical non-routine (complex) tasks, changes in job content and skill requirements, along with cognitive overload from managing advanced systems, are the main psychosocial risk factors mentioned. Solutions include worker engagement and communication to explain the changes in job content and reassurances on job security.

For tasks that combine cognitive and physical aspects, risk factors include cognitive overload, fear of job loss, lack of trust regarding the safety and reliability of automated systems, and the need for upskilling/reskilling.

As already discussed in section 2.1, the fear of job loss is a recurring theme across all types of tasks, indicating a universal concern among workers about the security of their employment in the face of advancing technology. Cognitive overload is another common risk factor for tasks that involve significant mental engagement or multitasking. Just as jobs should be planned to avoid a constant heavy physical workload and incorporate task variety and rest breaks into the work, the same approach is needed to avoid a constant high mental workload. Unlike machines, human beings need variety (of tasks, of degrees of effort required, etc.).

While the introduction of advanced robotics and AI into workplaces is presenting a range of psychosocial risk factors that vary by the type of task affected, the solutions tend to converge on a set of core strategies aimed at mitigating these risk factors. Training and worker involvement are universal solutions across all types of tasks, emphasising the importance of preparing workers for the introduction of new technologies and involving them in the implementation process. Communication and feedback mechanisms also stand out as crucial across different scenarios, ensuring that workers' concerns are addressed and their input considered when implementing new technologies. There are also solutions that are restricted to the psychosocial risk factors associated with technologies assisting with or replacing a type of task. For physical tasks, they are specific safety protocols and ergonomic considerations. For cognitive and combined tasks, solutions extend to social support structures, like counselling, and comprehensive reskilling programmes that address both the mental and skill-based adjustments needed. A brief summary can be found in Table 2 below.

Table 2: Main psychosocial risk factors by type of task replaced by digital technology and measures taken

Type of task	Main psychosocial risk factors	Measures
Cognitive routine	▪ Cognitive overload: Tasks that involve repetitive monitoring or data analysis can lead to mental fatigue. ▪ Fear of Job Loss: Concerns about AI replacing roles traditionally requiring human judgment.	▪ Training and education to deal with cognitive overload. ▪ Worker involvement to mitigate fears of job loss and resistance.
Cognitive non-routine (complex) tasks	▪ Need for upskilling/reskilling: The introduction of AI in tasks requiring high levels of skill necessitates additional training. ▪ Performance pressure: workers may feel pressured to match AI's efficiency, particularly in diagnostic and inspection roles. ▪ Lack of trust and initial resistance: Scepticism towards AI's effectiveness and its impact on professional autonomy.	▪ Upskilling/reskilling programmes to enhance workers' capabilities to work alongside AI, especially in high-skill areas. ▪ Clear communication and documentation offering detailed explanations of AI's role and impact to build trust. ▪ Social support structures to address performance pressure and the emotional impact of AI integration.
Physical routine	▪ Physical safety risks: Interacting with robots and machinery introduces concerns about physical injuries. ▪ Deskilling: Automation of manual tasks leads to concerns about the devaluation of manual skills.	▪ Comprehensive safety training on safely interacting with machinery addressing physical safety risks. ▪ Ergonomic considerations to minimise the risk of injury and ease the transition to new technologies. ▪ Gradual introduction of the technology to reduce resistance and build familiarity with automated processes.
Physical non routine (complex) tasks	▪ Changes in job content and skill requirements: Automation requires workers to oversee and manage the technology rather than performing the tasks, altering the nature of their work. ▪ Cognitive overload: Managing advanced systems can increase cognitive demands even in primarily physical tasks.	▪ Worker engagement and communication, ensuring workers understand the changes in job content and have a voice in the integration process. ▪ Providing reassurances on job security and highlighting the benefits of technology for safety and efficiency.
Cognitive and physical	▪ Cognitive overload: The need to adapt to and manage both cognitive and physical aspects of work. ▪ Fear of job loss: Concerns about the redundancy of human roles with the increasing capabilities of AI and robotics. ▪ Lack of trust: Anxiety about the reliability and safety of interacting with automated systems. ▪ Need for upskilling/reskilling: As tasks evolve, there's a significant emphasis on learning new skills.	▪ Training and reskilling. ▪ Worker involvement and feedback systems, facilitating a participatory approach for workers to express concerns and suggestions. ▪ Cybersecurity measures, building trust through robust security protocols, particularly where data handling and processing are involved. ▪ Attention to ergonomics and wellbeing, ensuring that the work environment is adapted to support workers' physical and mental health.

Source: author's elaboration based in EU-OSHA literature

When dealing with AI systems used to automate social tasks, it is important to consider the risk of depersonalisation or loss of personal connection and reduced social interaction among workers, clients, students or patients (EU-OSHA, 2022w). Indeed, while the technology may substitute tasks, it cannot replace the nuanced aspects of human interaction. To mitigate these effects, employers could use a number of strategies, such as regular team meetings and workshops to ensure that workers keep interacting with each other, as well as collaborative problem-solving sessions, feedback and discussion fora, and social events not necessarily related to work.

Over all, the adoption of advanced robotics and AI in the workplaces investigated in the case studies is associated with recurring psychosocial risk factors, including cognitive overload, fear of job joss, issues of trust towards new technologies, the need for upskilling and reskilling, and the transformation of job roles. The solutions companies put in place to prevent these risk factors aim to reach a balance between the increase in efficiency brought about by the introduction of digital technologies and the wellbeing of workers, by offering targeted training programmes, committing to transparent communication and involving workers in the process.

3.2 Smart digital systems

Smart digital systems, in the context of OSH monitoring, can be described as systems that use a range of digital technologies – such as sensor-based devices, artificial intelligence (AI), the internet of things (IoT), wearables, wireless technologies, augmented reality (AR), virtual reality (VR) and drones – to monitor, analyse, and manage workplace safety and health risks, including physical, ergonomic, chemical, biological and psychosocial, associated with various factors such as workers' activities or tasks, equipment, workplace layout and work organisation.

In the area of smart digital systems, EU-OSHA's literature comprises two main reports (EU-OSHA, 2023q; EU-OSHA, 2023r), five policy briefs (EU-OSHA, 2023s; EU-OSHA, 2023t; EU-OSHA, 2023u; EU-OSHA, 2023v; EU-OSHA, 2023w) and five discussion papers (EU-OSHA, 2021a; EU-OSHA, 2019b; EU-OSHA, 2020a; EU-OSHA, 2020b; EU-OSHA, 2023x).

According to the reports, the technologies used by smart digital systems include:

- **Sensor and camera-based technologies:** these technologies can play a significant role in monitoring and managing OSH risks. They include industrial applications, construction, mining and more, showcasing the cross-sectoral utility of such systems.
- **Internet of things (IoT):** IoT connects various devices and sensors within a single monitoring system. By enabling a seamless flow of information across multiple parameters, IoT is setting new standards for comprehensive workplace monitoring.
- **Wearable devices:** Wearables, including smart PPE, exoskeletons and other sensor-equipped gear provide real-time data on workers' health and safety conditions, which allows for instant detection of potential hazards or signs of deteriorating health.
- **Wireless technologies (e.g., Bluetooth, RFID):** These technologies enable wire-free communication among various devices within a monitoring system, ensuring that data are transferred and processed effectively. More specifically, Bluetooth allows devices to connect over short distances without physical cables, while RFID employs tags and readers to identify and track items automatically.
- **Augmented reality (AR) and virtual reality (VR):** AR and VR can be used to enhance training experiences by simulating real-world environments. AR overlays digital information onto the physical world, thus providing interactive guidance during tasks. VR immerses individuals in a fully digital environment, allowing them to practice procedures and recognise potential risks in a controlled setting.
- **Drones (unmanned aerial vehicles):** Drones are devices operated remotely. They are used for observing and examining areas or situations that may pose risks to human safety and enable efficient monitoring of workplace conditions from a safe distance, therefore reducing individuals' exposure to potential hazards.

These systems can collect data on the work environment and on workers, including images, audio, video, environmental data, health data, behavioural data and body posture data. It should be noted that in many cases the collection of data, especially when sensitive and personal, must comply with EU's General Data Protection Regulation (GDPR) regulations.

The two reports also mention technologies already addressed in the previous sections, such as artificial intelligence and machine learning (ML) as they are pivotal in analysing the data collected through monitoring systems.

Both reports examine the implications, advantages and challenges of employing digital technology for monitoring and improving workplace safety and health and discuss how these technologies can be used to detect and manage various workplace risks. However, while the first report focuses on the risks and challenges related to the technologies, with an explicit mention of psychosocial risks, the second report does not explicitly mention psychosocial risks but implies their existence in the monitoring capabilities of these systems.

The five discussion papers focus on: combining digital tools, monitoring technology sensors and AI to carry out dynamic risk assessments (EU-OSHA, 2021a); the impact of exoskeletons on OSH in general (EU-OSHA, 2019b) and on musculoskeletal disorders in particular (EU-OSHA, 2020a); the promises and challenges of smart personal protective equipment (PPE) (EU-OSHA, 2020b); and the OSH implication of unmanned aerial vehicles or drones (EU-OSHA, 2023x). The discussion papers raise concerns around user acceptance and trust, invasion of privacy, reliability of the technology and a number of other psychosocial risk factors detailed below.

- **Smart digital systems and psychosocial risks**

The psychosocial risk factors associated with the introduction of smart digital systems in the workplace are very similar to those associated with the introduction of advanced robotics and AI, but there tends to be a stronger focus on data privacy issues.

Lack of trust: Trust between workers and employers, as well as among coworkers, is a critical factor in the successful implementation and acceptance of these technologies in the workplace. Digital surveillance may lead to the invasion of privacy with workers feeling a sense of mistrust towards their employers. This perception might be strengthened by a lack of transparency regarding data collection and analysis, or if the criteria used for making hiring, firing, promoting or retaining workers are not clearly communicated or understood (or perceived as biased – see 'sense of unfairness' below). Addressing these concerns requires clear communication about data usage, security and privacy protections. In addition, trust (or acceptance) in the technology is fundamental to avoid misuse or underuse, as highlighted in the discussion paper on smart PPE (EU-OSHA, 2020b).

Sense of unfairness: If the monitoring technology is perceived as invasive or biased, it can foster a sense of unfairness among workers. The shift to algorithmic management and the lack of transparency on how decisions are taken can also lead to a widespread sense of unfairness.

Workload increase and time pressure: Smart digital systems may be perceived as tools to enhance efficiency, which may raise expectations on productivity, which in turn result in increased time pressure and workload for workers, associated with increased stress.

Lack of autonomy: Where smart digital systems dictate work pace and methods they reduce workers' control over them. This loss of autonomy may demotivate workers and diminish their job satisfaction, as they feel more like cogs in a machine rather than valued workers. In addition, when associated with increased pressure or high demands, it can result in stress, as posited by the Karasek model.

Poor communication and social relationships: The technology may reduce face-to-face interactions, either among peers or between managers and the worker, negatively affecting workplace relationships and communication. This in turn may result in a less cohesive and supportive work environment, and give rise to more misunderstandings and conflicts, and a feeling of workers' isolation which can affect their mental health.

Lack of training on new technologies: The deployment of new digital monitoring systems often requires workers to learn new skills or adapt to new procedures. A lack of adequate training can leave workers feeling unprepared and anxious, potentially leading to errors or inefficiencies, further exacerbating stress and dissatisfaction.

EU-OSHA's literature addresses each of these risks and proposes solutions emphasising the need for data privacy and security, consultation and participation of workers, enhancing human accountability in

data interpretation, and adapting legal and policy frameworks to address the challenges posed by digital tools in the workplace.

3.3 Digital platform work

Based on the reports: 'Digital platform work and occupational safety and health: a review' (EU-OSHA, 2021e) and 'Digital platform work and occupational safety and health: overview of regulation, policies, practices and research' (EU-OSHA, 2022v), digital platform work can be defined as all *paid labour mediated through online platforms, characterised by non-standard working arrangements, algorithmic management, involvement of three parties, and a shift of risks and responsibilities to workers*. Mateescu & Nguyen (2019) define algorithmic management as 'a diverse set of technological tools and techniques to remotely manage workforces, relying on data collection and surveillance of workers to enable automated or semi-automated decision-making.'

Aside from the two main reports mentioned above, the EU-OSHA literature on digital platform work also includes two policy briefs (EU-OSHA, 2021l; EU-OSHA, 2022g), two discussion papers (EU-OSHA, 2023aa; EU-OSHA, 2023) and eight case studies; half of the case studies have a policy focus, while the other half investigate the occupational safety and health (OSH) risks associated with different types of platform work. Each case study looks at one of the four distinct categories of tasks mediated through digital labour platforms analysing in depth an example of platform work falling in each category: low-skilled on-location (e.g., parcel delivery), high-skilled on-location (e.g., handiwork), low-skilled online (e.g., content moderation) and high-skilled online (e.g., programming). The methodology combines a review of academic and grey literature, with targeted interviews with platform workers and platform stakeholders.

- **Psychosocial risk factors identified in the case study analysis**

A cross-case analysis of the case studies on digital labour platform reveals that some psychosocial risk factors are pervasive across all forms of platform work, since they stem from fundamental features such as algorithmic management or precarious work arrangements; by contrast, certain risks are inherently linked to the specific nature of the tasks or the working environment. For instance, the use of algorithmic management and automated procedures in digital labour platforms can be particularly stressful for workers carrying out all sorts of tasks, as it creates an environment of high control and monitoring, reduced job autonomy, low job security, performance pressure (due to the need to keep high customer ratings) and lack of clear communication and feedback. In addition, all platform work is based on temporary, short-term assignments that do not guarantee any long-term work relationship. Research on safety and health in platform work emphasises the impact of precarious employment conditions, including low income, irregular working times, lack of autonomy and control, job insecurity, unconventional workplaces and a lack of collective representation on the physical and psychological health and wellbeing of platform workers (EU-OSHA, 2022v; EU-OSHA, 2021e). At the same time, the nature of tasks performed may be linked to different psychosocial risks. Stress is prevalent among online platform workers due to factors such as algorithmic management and digital surveillance. The stress is exacerbated by the dependency on maintaining a good reputation and receiving positive reviews for future work assignments, since high ratings may lead to more job offers or the ability to charge higher rates, whereas low ratings can restrict access to work opportunities, creating a precarious financial situation for the workers (EU-OSHA, 2024).

In more detail, the psychosocial risk factors common to all four categories of platform work include the following.

Professional isolation: All case studies highlight isolation as a significant issue due to remote or flexible work arrangements limiting workers' interactions and support networks. It should be mentioned that, while often present in the literature, empirical analyses carried out in two EU Member States have found relatively little support for this risk, with platform workers generally reporting being able to communicate with colleagues or supervisors if needed, regardless of the type of task carried out (Fernandez Macias, Urzi Brancati, Wright, & Pesole, 2023).

Workload increase and time pressure: Reported across all types of work, reflecting the pressures to meet deadlines and manage large volumes of tasks, exacerbated by algorithmic management, which

generally imposes rapid task completion within tight time constraints, dictates the pace and scheduling of tasks, or optimises scheduling by reducing workers' downtime.

Job and income insecurity: This is a pervasive concern due to the nature of platform work, where fluctuating demand and platform dependency lead to uncertainties regarding job continuity and income stability, affecting all workers irrespective of their task type or skill level**.**

Lack of autonomy: Workers in all categories face limited control over their work conditions and schedules, with tasks and evaluations heavily influenced by algorithmic management and client ratings.

Sense of unfairness and lack of trust: Workers performing all four different types of platform work experience feelings of unfairness, often due to the lack of transparency of algorithmic decision-making and evaluation processes.

Some psychosocial risk factors are instead typical of certain sets of tasks.

Exposure to distressing content: Unique to content moderation (as example of low-skilled online work), which involves reviewing harmful or illegal content, leading to a higher risk of psychological trauma and stress disorders. This can result in post-traumatic stress disorder.

Cognitive overload: Particularly relevant for online remote programming (as example of high-skilled online work), where tasks require intense mental focus and can lead to cognitive fatigue and stress.

Poor work-life balance: While this can affect all categories, it is especially pronounced in online work (both low and high skilled) due to the blurred boundaries between work and personal life, exacerbated by the global nature of platform demand leading to odd working hours.

In addition, physical health risks are reported to be more prevalent in the examples of on-location work (both low and high skilled), these risks include potential accidents and exposure to physical hazards during parcel delivery and handiwork**.** Some platform workers may also face violence, harassment and abuse, and being exposed to crime (Eurofound, 2018a; ILO, 2021). The literature suggests that these are concerns particularly for on-location platform workers working as taxi drivers or delivery riders (EU-OSHA, 2021e).

The four case studies present a compelling argument to address the specific OSH challenges in the digital labour platform economy. A consensus emerges that the labour market status of platform workers as freelancers or self-employed shifts the burden of OSH risks prevention and management onto the worker, so all reports call for a re-examination and expansion of current OSH regulations to fully recognise and protect platform workers, independently of their employment status. Proposed solutions include the provision of insurance, training, and appropriate equipment and proper ergonomic practices, especially for on-location tasks; measures to address professional isolation and work-life balance. Platforms should also provide guidance on task performance and conduct regular assessments to mitigate psychosocial risks. Finally, facilitating collective bargaining and representation is seen as a crucial strategy to address job and income insecurity.

The reports also underline the necessity for specific OSH guidelines tailored to the unique demands of platform work and stress the importance of enforcement and monitoring to ensure compliance and protect workers' rights effectively.

The risks to taxi drivers and delivery workers, including violence, were already well known before the advent of platform work. Previous EU-OSHA reports (EU-OSHA, 2011) document the guidance and measures that existed to deal with them. Guidance and measures need updating to apply to the new work context. OSH measures for existing risks as well as new risks need addressing when work is moved to platforms.

3.4 Remote working

The adoption of technologies allowing for remote work or telework has seen a massive increase following the COVID-19 pandemic: data from the OSH Pulse survey show that almost 30% of people employed in the EU-27 worked away from either the employer's or the client's premises; while approximately 17% worked from home (EU-OSHA, 2022). People working from home were also more likely to use laptops, tablets, smartphones or other portable computer devices and to use broadband technology to access the Internet.

EU-OSHA's literature reviewed for this section includes five reports (EU-OSHA, 2021d; EU-OSHA, 2021b; EU-OSHA, 2021c; EU-OSHA, 2023gg; EU-OSHA, 2023z) and three discussion papers (EU-OSHA, 2021j; EU-OSHA, 2023; EU-OSHA, 2024).

The following definitions of remote work, telework and hybrid work are based on EU-OSHA's literature.

- **Remote work**: Defined as 'any type of working arrangement involving the use of digital technologies to work from home or more generally away from the employer's premises or in a fixed location' (EU-OSHA, 2023z).
- **Telework**: As per the 2002 European cross-sector social partners' framework agreement, telework is defined as 'a form of organising and/or performing work using information technology in the context of an employment contract/relationship where work which could also be performed at the employer's premises is carried out away from those premises on a regular basis' (EU-OSHA, 2021d).
- **Hybrid work**: is defined as 'a combination of telework and work at the employer's premises, where an employee may work both from the office and from home (or from another location like a café or during transport, etc.)'. In practice, hybrid work is mainly performed from home (telework) and at the employer's premises, with the weekly distribution of teleworking and on-site work periods varying widely (e.g., one, two, or more days of telework per week). Hybrid workers use digital technologies and an Internet connection for work 'always' or 'almost all of the time', regardless of the location of work (EU-OSHA, 2023).

Remote working technologies offer workers flexibility and autonomy, potentially raising their productivity; they can be particularly beneficial for workers with chronic musculoskeletal disorders and to workers with fluctuating health conditions, for example because health flare-ups can be better managed at home and fatigue can be reduced by not having to travel to work (EU-OSHA, 2021h). However, the reports also highlight the exposure to a number of psychosocial risk factors related with the nature of work outside the office environment. These include issues related to work-life balance, feelings of isolation, constant connectivity and extended availability leading to increased workload, reduced autonomy, and poor social relationships due also to increased communication problems. These risk factors can not only affect workers' mental and emotional well-being but also have implications for organisational productivity and health and safety practices.

These issues are exacerbated in workplaces adopting 'surveillance organisational models', in which organisations employ at least one digital technology to control workers' behaviour, performance, or physiology (EU-OSHA, 2023z).

Understanding the potential risks and putting in place policies to prevent or manage them is particularly important as telework, remote work and hybrid work are going to become increasingly common in the future. According to an EU-OSHA report providing field evidence on telework during the pandemic (EU-OSHA, 2021i) most companies are discussing plans to extend telework and most workers express a preference for continuing with regular telework in the future or at least would like the opportunity to request occasionally working from home.

- **Remote working and psychosocial risks**

Common challenges related to psychosocial risks identified by the EU-OSHA literature include those listed below.

Work-life balance issues: One of the most notable consequences in terms of psychosocial risks of telework, as demonstrated by the mass shift to telework brought about by the COVID-19 pandemic, is the blurring of work-life boundaries. The home environment, traditionally a personal space, became for many a workspace: many people found themselves working in their living rooms or kitchens, spaces not designed for work, often lacking the basic ergonomic features of an office. In addition, the flexibility of telework, while generally beneficial, often resulted in work extending into evenings and weekends, exacerbating work-life conflicts. Video-conferencing tools and other digital devices used to replace in-person communication often meant that people were pressured into replying to emails outside working hours. In addition, the lack of a clear separation between work and home is seen as particularly challenging for those who have care responsibilities, generally women.

Increased workload/extended working hours: The pervasiveness of digital technologies in telework often leads to extended availability and increased workload. Workers may also find themselves working more intensively and taking fewer breaks, because they work during what would have been commuting time and lose those breaks and casual interactions typical of office environments. In addition, the convenience of being able to work from home means that many are more likely to work when unwell, and not take the sick leave they are entitled to.

Isolation/poor social communication: The isolation felt by teleworkers, already a concern pre-pandemic, became worse during COVID-19. Workers may feel disconnected from colleagues or the organisation due to the absence of those informal, spontaneous interactions that often occur in physical office spaces. This situation was particularly challenging during lockdowns, where social activities outside work were also restricted, increasing feelings of isolation. While technology facilitated continued formal communication, the lack of casual 'water cooler' chats affected social relationships at work. The attempt to replace physical interactions with virtual meetings alleviated the issue, but only to a certain degree, as they could not fully replace the spontaneity and warmth of face-to-face conversations. In addition, teleworkers may worry about being forgotten or overlooked by colleagues and supervisors due to physical absence.

Reduced work autonomy: The reports discuss how teleworking can lead to a perception of reduced autonomy over work tasks, largely due to remote monitoring and management practices. The use of monitoring tools like time tracking software, which may take screenshots of workers' screens or log keystroke and mouse movement rates, or more intrusive tools monitoring communications, including emails, chat messages and phone calls, may feel particularly invasive significantly to teleworkers' sense of personal autonomy and control over their work environment.

A recent EU-OSHA report investigating the gender dimension of telework reveals how it disproportionately affects women in terms of work-life conflict, stress and health outcomes (EU-OSHA, 2024). The report explains how women tend to face higher work-life conflict and stress levels due to the blurring of boundaries between work and private life, which is intensified by the responsibilities of care and household work that predominantly fall on them. According to the report, women who telework also experience more severe time pressure or work overload compared to their male counterparts, suffer more frequently from headaches, eye-strain and fatigue, as well as worse mental health. It should also be added that according to several studies, the mass shift to telework during the COVID-19 pandemic has coincided with a significant increase in reported domestic violence, with cases of women seeking help more than doubling (EU-OSHA, 2023dd). While domestic violence is not generally considered a work issue, it may spill from the private sphere into the world of work, therefore employers can help potential domestic violence victims by implementing the policies suggested by the International Labour Organization (ILO) (Recommendation n.206), such as providing leave, flexible work arrangements, temporary protection against dismissal and so on.

In conclusion, the analysed reports emphasise the need to address the psychosocial issues connected with telework and remote work through targeted policies, the adoption of flexible work practices and robust support systems. They advocate for comprehensive strategies that prioritise the wellbeing of workers without compromising the goals of the organisation, and suggest the adoption of a collaborative approach between employers and workers to meet this need.

3.5 Artificial intelligence for worker management (AIWM)

Artificial intelligence for worker management (AIWM) technologies are systems that collect data, often in real time, from the workspace, workers and their activities. These data are then processed by AI-based systems to make automated or semi-automated decisions, or to provide information to decision-makers such as HR managers, employers and sometimes workers themselves. The primary objective of AIWM systems is to improve the productivity and efficiency of workers, which can be achieved through various means including enhanced worker monitoring and surveillance, such as performance, safety and emotions monitoring (EU-OSHA, 2022ee; EU-OSHA, 2022f).

EU-OSHA's literature on AIWM comprises three main reports (EU-OSHA, 2022y; EU-OSHA, 2022ee; Urzì Brancati, Curtarelli, Riso, & Baiocco, 2022), and four policy briefs (EU-OSHA, 2022ff; EU-OSHA, 2022x; EU-OSHA, 2022p; EU-OSHA, 2022n).

Data on the prevalence of AIWM are still relatively scarce; the OSH Pulse survey provides information on whether digital devices used for work (including tablets, smartphones, computers, laptops, apps and sensors) are also used to perform a number of managerial functions. According to the survey, such devices are used to automatically allocate tasks, working time or shifts for 30% of the respondents; for 27% of respondents, devices were used to have their performance rated by third parties (e.g., customers, colleagues, patients, etc.); while 25% said that they were used to supervise or monitor their work and behaviour (EU-OSHA, 2022r). Overall, 78% of the total workers interviewed declared to be under some form of AIWM (EU-OSHA, 2023z). In addition, workers reported that an increase in the use of surveillance digital tools corresponded to a higher perceived psychosocial risk, and this is particularly true for unskilled workers who reported higher negative health outcomes (EU-OSHA, 2023z).

Data from the European Survey of Enterprises on New and Emerging Risks (ESENER) shows that a relatively low, but not irrelevant proportion of European workplaces, use digital technologies for worker management, and in particular less than 10% uses 'machines, systems or computer monitoring workers performance', while approximately 13% use 'machines, systems or computer determining the content or pace of work' (Curtarelli & Urzì Brancati, 2021). According to the joint report carried out by EU-OSHA, the JRC and Eurofound (Urzì Brancati, Curtarelli, Riso, & Baiocco, 2022), roughly 28% of the workplaces interviewed for the European Company Survey (ECS) use data analytics either for process improvement or for employee monitoring, while Eurostat data shows that a fairly large proportion of workplaces used management software such as Enterprise Resource Planning (ERP), 38%, or Customer Relationship Management (CRM), 35%. The reports also highlight how the prevalence of these technologies tends to be higher in larger companies and in economic sectors.

- **Artificial intelligence for worker management and psychosocial risk factors**

According to the reports, the adoption of AIWM appears to be significantly associated with a very high number of psychosocial risk factors. It is also linked to physical health risks, including musculoskeletal and cardiovascular disorders, arising from the nature of work management and monitoring (EU-OSHA, 2022y). It should also be mentioned that many of these findings come from a mix of qualitative and quantitative research, and are therefore very robust.

The psychosocial risk factors mentioned in the reports and policy briefs are the following.

Time pressure: Empirical evidence from ESENER shows the presence of AIWM technologies is associated with an increase in reported time pressure among workers. The association is particularly strong for digital technologies monitoring workers' performance, highlighting the stressful impact of continuous surveillance on workers. This constant monitoring likely places workers under relentless scrutiny, pushing them to meet tight deadlines and maintain high productivity levels (Curtarelli & Urzì Brancati, 2021; EU-OSHA, 2022ee).

Poor communication or cooperation: Empirical evidence from ESENER shows that workplaces adopting AIWM technologies are more likely to report poor communication or cooperation and this is especially true for those that use digital technologies to monitor workers. This suggests that the surveillance aspect of these technologies may contribute to a decrease in trust among colleagues, potentially disrupting team dynamics and collaboration (Curtarelli & Urzì Brancati, 2021; EU-OSHA, 2022ee).

Fear of job loss: Workplaces adopting AIWM tools are more likely to report fear of job loss compared to workplaces in which these technologies are not present. In the case of management technologies for worker monitoring, the likelihood is almost double (10.6% versus 18.9% according to Curtarelli & Urzì Brancati, 2021). The fear of job loss not only affects the morale of workers but also contributes to stress, anxiety and uncertainty about future employment prospects.

Workload increase/intensification of work: Since AIWM technologies are adopted explicitly to increase productivity and improve efficiency, it is not surprising that they may lead to the intensification of work. When AIWM technologies are used to determine the pace and content of work, for instance, they tend to minimise non-work activities, breaks and so on, with workers being pushed to work at high speed for longer periods and without appropriate rest. Warehouse operations are a typical example of work intensification due to the adoption of AIWM technologies, with the technologies monitoring order completion times, worker movements and whether they respect their scheduled breaks, all aimed at enhancing work speed. This emphasis on efficiency and productivity can potentially overshadow

concerns over workers' health and wellbeing and lead to higher stress levels, heightened risk of burnout, physical discomfort and a decline in job satisfaction (EU-OSHA, 2022x).

Cognitive overload: Constant monitoring or data processing demands can lead to cognitive overload. In addition, workers who are managed with the support of digital tools and systems determining content and pace of work are more likely to be exposed to information overload, and are therefore more likely to experience feelings of guilt and anxiety about their inability to meet the demands placed upon them. This can result in 'relentless self-exploitation, often justified by both workers and employers as "flexible working"' (Berastegui, 2021: 36).

Work-life balance issues: The deployment of AIWM technologies, especially those enabling continuous monitoring, has contributed to an increasingly porous boundary between work and personal life, as discussed in the section on telework, with workers finding it hard to disconnect from work if they are expected to be available beyond traditional working hours (EU-OSHA, 2022y).

Lack of trust/sense of unfairness: Workplaces that adopt AIWM technologies likely collect huge amounts of data on their workers. The collected data can then be used to evaluate performance and inform decisions on promotions, retention, scheduling and so on. If these decisions are not made transparently, which can be the case, workers may distrust their managers or employers. Creating a participatory approach where workers have a say in how AIWM systems are used can help rebuild trust (EU-OSHA, 2022x).

Lack of Autonomy/control: AIWM technologies determine pace and content of work, task assignments and evaluations, significantly reducing the scope for personal discretion and decision-making by workers, leading to a feeling of being micromanaged by an impersonal system. Workers deprived of autonomy may experience higher levels of job-related stress, decreased motivation and a sense of alienation from their work. In addition, the loss of autonomy can also stifle creative thinking and innovation among workers, as it limits their ability to explore alternative methods or solutions outside the prescribed algorithms (EU-OSHA, 2022x).

Worker deskilling/lack of Training: Finally, the reports and policy briefs discuss lack of training as a recurrent psychosocial risk factor arising because of the introduction of AIWM technologies. Like in the case of other digital technologies discussed in this report, this problem emerges when workers are not provided with adequate instruction or resources to understand and adapt to new technologies implemented in the workplace. The lack of training on the use and implications of AIWM systems can leave workers feeling incompetent and unsure about how to interact with these technologies. This affects their ability to perform tasks efficiently, as well as also reducing their confidence, potentially leading to stress and anxiety (EU-OSHA, 2022x; EU-OSHA, 2022y).

In conclusion, the adoption of AIWM technologies in workplaces is associated with recurring psychosocial risks, including time pressure, workload increases, cognitive overload, fear of job loss and lack of trust due to the opaque nature of automated decisions. The solutions suggested in the reports mainly focus on transparency, a participatory approach in which workers are able to provide feedback on the way their data are used, and specific rules to prevent work from spilling over into workers' private life. Other solutions are focused on reskilling and upskilling initiatives, therefore investing the professional development of workers, especially to counteract the fear of job loss and perceived lack of training.

4 Current legislation and good practices

The EU-OSHA literature consistently highlights the lack of specific legislation aimed at mitigating the impact of digitalisation on OSH; although existing OSH regulations generally apply, provided the workers are classified as *employees*. However, some non-binding general principles in relation to OSH and digitalisation are provided by the main European OSH stakeholders, like the EU Commission and the social partners, for example, in the European Social Partners Framework Agreement on Digitalisation (EU-OSHA, 2022d). On the other hand, some of the EU legislation specific to digitalisation is relevant to OSH. Rather than addressing digitalisation in general, the current EU legislation on digitalisation refers to specific technologies examined in this report, and in particular to artificial intelligence, teleworking technologies and digital labour platforms. In addition, some of the Member States are developing their own policies and strategies and some companies are implementing workplace policies.

4.1 Artificial intelligence (including AIWM)

The EU's General Data Protection Regulation (GDPR) regulates the processing of personal data, and although it does not include specific protection for workers or employees, many of its provisions apply to the employment relationship, and it is particularly relevant for AIWM and algorithmic management. Articles 13 and 14 mandate that data subjects (in this case workers) be informed when their personal data are collected, the purposes for which they are used and the duration of their storage. If automated decision-making, including profiling, is involved, workers have the right to understand the logic behind these processes. Article 22 prohibits fully automated decisions for dismissing or punishing individual workers (based on processed data) without meaningful intervention of a human manager. Article 22(3) also sanctions the right to an explanation; when an automated decision is taken, the data controller has the obligation to inform the data subject of the reasons that led to that decision and provide details as to what parameters it has used to reach the decision in question. Additional rights include the right to rectification (Article 16), the right to be forgotten (Article 17) and the right to data portability (Article 20)[2].

In recent years, many national governments have undertaken policy initiatives with the aim of maximising the benefits while reducing the risks of AI. These policies vary widely in their goals and focus, ranging from detailed plans for implementing AI in various sectors, to broader visions for future AI development. Most national initiatives, however, appear to lack specific strategies for addressing OSH related issues (EU-OSHA, 2022k), as they appear to focus exclusively on the economic benefits and harms potentially associated with the widespread adoption of AI. These policies are framed as 'industrial strategies', hence focusing on economic growth through investment in AI, rather than on protecting workers. Indeed, one of the concerns raised in the EU-OSHA literature is that promoting what is good for business in the short term may come at the expense of workers, with OSH related risks brushed aside (EU-OSHA, 2022k; EU-OSHA, 2022c).

Furthermore, since AI systems operate globally, regulations at the national level may not be sufficient and could lead to a fragmented and costly regulatory environment. This scenario could force businesses to navigate varying standards and potentially encourage them to relocate to countries with less stringent regulations. Indeed, effective regulation of AI in the workplace requires international cooperation and consistent policy objectives/standards to balance the need for economic competitiveness with worker protection.

4.1.1 Current legislation

Artificial Intelligence Act (AI Act)

The AI Act (COM(2021/206)[3] is part of a broader initiative by the EU to manage the digital transformation in ways that promote safety, equity and privacy. Its aim is to ensure that AI systems are safe and respect existing laws on fundamental rights and values. In terms of the impact of the technology on work, the AI Act addresses i) AI systems used for recruitment; and (ii) AI systems used for promotion and termination

[2] Available at: https://eur-lex.europa.eu/eli/reg/2016/679/oj

[3] Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts, COM (2021) 206 final (April 22, 2021). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206

of contracts for work, for allocating tasks and for monitoring and evaluating workers' behaviour (p.26, n. 36). While the AI Act does not directly address OSH concerns, it classifies AI according to its risk levels and sets strict standards for high-risk AI applications in sensitive areas, including employment and workers' management. AI should be safely integrated in the workplace by not undermining worker safety or wellbeing, thus aligning with general OSH objectives.

National initiatives

Countries including Germany, France, Sweden and Norway have developed national strategies that address the integration of AI in workplaces. These strategies focus on continuous education, skill acquisition and ensuring that AI supports workers without replacing them (EU-OSHA, 2022k).

- Germany's 'Artificial Intelligence Strategy' emphasises the integration of AI to benefit society and the workplace and advocates for continuous education and reskilling to cope with changes brought by the technology. The strategy advocates for the design of technology that supports human work rather than replacing it, focusing on easing burdens and enhancing human abilities like empathy and creativity.
- France's initiative 'For a Meaningful Artificial Intelligence: Towards a French and European Strategy' predicts significant changes in the workplace due to AI, with a substantial number of jobs at risk of automation. The strategy highlights the need for a major overhaul in education and training to prepare the workforce for this transition, as well as strategic workforce planning to deal with potential job losses.
- Sweden's 'National Approach to Artificial Intelligence' focuses on enhancing technical expertise, supporting AI research and fostering innovation. However, the strategy is criticised for its heavy focus on business interests over labour concerns, with little direct attention to the impact on workers.
- Norway in its 'National Strategy for Artificial Intelligence' highlights the need for significant investment in education to mitigate job redundancy and displacement. The strategy also discusses ethical concerns and data privacy issues related to AI in workplaces.

4.1.2 Good practices

The case studies carried out by EU-OSHA on AI and advanced robotics highlight key practices accompanying the adoption of digital technologies that have proven beneficial.

Training and upskilling are the most frequently cited practice to help workers deal with the introduction of AI and advanced robotics. This practice involves providing comprehensive training sessions to workers, ensuring they are well-equipped to handle new equipment and processes, and thus improving their skills while boosting confidence and reducing stress related to potential job displacement.

Worker involvement and engagement is another critical practice mentioned in more than half of the case studies. By involving workers in the planning and implementation phase of new technologies, companies can mitigate feelings of uncertainty and helplessness that often accompany these types of changes in the workplace. This practice not only fosters a sense of ownership among workers but also helps identify potential issues early, allowing for a more seamless integration of new technologies. Examples include the collaborative robot implementations in Portugal and the AI-based systems in Germany, where worker feedback and involvement were integral to the process.

Finally, **clear and open communication** is crucial for managing the psychological risks associated with the introduction of AI and advanced robotics in the workplace, especially in terms of trust and fear of job loss. In particular, it is essential to inform workers about what the technological changes entail, that is, what will be the operational changes, the new safety protocols and procedures for emergency situations, how these changes will affect individual roles and what workers can expect, so as to reduce fears and build trust between management and staff.

4.2 Telework

Prior to the COVID-19 pandemic, telework was a prerogative of a few, often privileged workers, employed in higher skilled, higher paying jobs: in 2019, less than one in twenty workers worked from home regularly, while in the first semester of 2020 the proportion soared to roughly a third or more of workers (Sostero, Milasi, Hurley, Fernández-Macías, & Bisello, 2020). This large and sudden shift posed

considerable challenges for organisations, which had to ensure technological infrastructure and support for workers' health and productivity. Additionally, it became clear that the existing regulations needed updating to reflect the current circumstances. Legal changes and policy debates on telework encompass four main aspects: the statutory definition of telework, the right to disconnect, the right to telework and OSH provisions (EU-OSHA, 2023gg; EU-OSHA, 2021d).

4.2.1 Current legislation

In 2020, EU-OSHA conducted a consultation with its national focal points to gather information on existing legislation on telework and any recent changes or debates caused by the pandemic. The information collected was analysed and presented in the 2021 publication 'Regulating telework in a post-COVID-19 Europe' (EU-OSHA, 2021b). While prior to the pandemic telework was not explicitly regulated at the EU level, several directives and regulations indirectly applied. The main reference for national legislation and collective bargaining on telework in most EU Member States is the EU Framework Agreement on Telework of 2002, which is not legally binding but serves as a guideline. The agreement provided a statutory definition of telework and covered various aspects of telework arrangements, such as employment conditions, data protection, privacy, equipment provision, health and safety and training. The agreement also emphasised that telework should be voluntary and reversible and outlined the rights of teleworkers to collective representation. According to the report, before the pandemic, as many as 20 European countries (Belgium, Bulgaria, Czechia, Germany, Estonia, Spain, France, Greece, Hungary, Croatia, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia and Slovakia) already had specific legislation and a statutory definition of telework – understood as a type of work arrangement, rather than type of contract. In terms of working conditions, most countries adopted the principle of equal treatment for teleworkers compared to on-site workers. Only four countries, notably Belgium, Spain, France and Italy had already guaranteed new employment rights for teleworkers, such as the right to disconnect – an issue that has now become critical.

In 2023, EU-OSHA provided a more up-to-date picture of recent regulatory reforms on telework with an analysis of the contributions from the European Foundation for the Improvement of Living and Working Conditions (Eurofound) Network of National Correspondents and additional desk research (EU-OSHA, 2023gg). The report outlines the main issues addressed by countries that have implemented or updated regulations on telework following the COVID-19 pandemic; these issues include statutory definitions of telework, the right to request telework, the right to disconnect, compensation for telework costs and OSH provisions on employers such as carrying out risk assessments and the prevention of psychosocial risks with measures including regular communication and support systems. In addition, the right to request telework is an important regulatory provision that can have positive implications for work-life balance and labour market integration of women (in particular mothers) (EU-OSHA, 2024).

Box 1: Work-life balance, telework and the right to disconnect

One notable initiative at the EU level is the European Parliament's resolution passed in January 2021 on the right to disconnect. Under the European Parliament's right of legislative initiative, Parliament's Committee on Employment and Social Affairs (EMPL) prepared a draft report after extensive stakeholder consultation.[4] While the Committee acknowledges the benefits of telework, the report also focuses on some of its challenges and regulatory issues. The report highlights the lack of specific European or international directives focusing solely on teleworking, but notes that existing EU directives on working time, health and safety and work-life balance are applicable.[5] It stresses the importance of ensuring that teleworking is voluntary and reversible, maintaining equality between teleworkers and their on-site counterparts, and safeguarding workers' rights, including health and safety standards. The Committee identifies challenges such as the risk of 'always-on' work culture and the need for clear boundaries to prevent worker burnout. Solutions proposed to mitigate this risk include promoting the right to disconnect – that is, the right of workers to not be contacted for work

[4] Opinion of the European Economic and Social Committee on 'Challenges of teleworking: organisation of working time, work-life balance and the right to disconnect' (Exploratory opinion at the request of the Portuguese Presidency). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020AE5278&qid=1653398952673

[5] Directive 2003/88/EC on the organisation of working time; Council Directive 89/391/EEC on safety and health at work; Directive (EU) 2019/1152 on transparent and predictable working conditions in the EU; and Directive (EU) 2019/1158 on work-life balance.

purposes outside of working hours – and ensuring that telework arrangements do not compromise workers' rights or safety. The Committee also highlighted the crucial role of social partners in implementing the right to disconnect and emphasised the need for solutions tailored to the specific needs and constraints of different companies, depending on their national and regional contexts, sectors and industries.

In June 2021, the Council acknowledged the growing prevalence of telework and its implications, urging Member States to devise national action plans that address its opportunities, limits and risks. It suggested amendments to telework policies or new guidelines, particularly concerning work time management, gender equality and telework expense allowances. Additionally, the Council called on the Commission to analyse the extent to which current social and labour law in the EU ensures decent working conditions for teleworkers.

In response to the Parliament's resolution, the Commission pledged to follow up by first engaging with social partners to find common solutions to the challenges associated with telework, digitalisation and the right to disconnect. In June 2022, three European employers' organisations signed a social dialogue agreement with European trade union representatives with a commitment to negotiate a legally binding agreement on telework in the form of a directive. The idea was to update the 2002 Autonomous Agreement on Telework, adopt it as a legally binding agreement and then ask the Commission to transcribe it into a European directive, as foreseen in the European rules on social dialogue. However, after more than a year, the negotiations failed. EU trade unions' representative reported in November 2023 that two of the employers' organisations (Business Europe and SME United) refused to put forward any text. Therefore, they called on the Commission to initiate legislative action. On 12 December 2023, the Commissioner for Jobs and Social Rights, Nicolas Schmit, assured MEPs in plenary that the Commission would follow up on the commitment made by the President, Ursula von der Leyen, to legislate on the right to disconnect.[6]

4.2.2 Good practices

EU-OSHA's report on the risks of teleworking and prevention strategies (EU-OSHA, 2021d) identifies several good practices for managing telework, particularly with respect to OSH and employee wellbeing, across a number of companies based in countries such as Germany, Spain, France, Italy, Malta, Portugal, Poland and Romania.

The first step to manage telework/remote work effectively is the establishment of comprehensive teleworking agreements, as shown in the example of companies like Orange in France. These agreements cover ergonomic setups, work-life balance, and include clauses that protect the right to disconnect. Indeed, guaranteeing the right to disconnect is a practice emphasised across various company and sector-specific agreements in different countries, as it is recognised as crucial for preventing employee stress and burnout.

Another crucial aspect is the provision of ergonomic support and necessary equipment to teleworkers. Companies such as Orange (France), Netguru (Poland), Acciai Speciali Terni and Credito Cooperativo Bank (Italy), as well as the Spanish banking sector, took on the responsibility to ensure that workers had the proper equipment, such as computers, laptops and ergonomic chairs to work from home. Examples of financial support for telework-related expenses can be found in companies, such as Gozo (Malta) and the Spanish banking sector, which help workers set up a home office that meets safety standards.

Finally, it is important to mention that the involvement of social partners is crucial to manage telework effectively through collaborative arrangements between employers, workers and trade unions. Examples from the Spanish banking sector, Credito Cooperativo, and Orange in France show that negotiating and managing telework arrangements with the involvement of trade unions and other representative organisations helps in ensuring that these agreements are comprehensive, fair and tailored to the needs of all stakeholders.

[6] See: https://www.europarl.europa.eu/legislative-train/theme-a-europe-fit-for-the-digital-age/file-al-legislative-proposal-to-the-commission-on-the-right-to-disconnect

4.3 Digital platform work

This section examines the policies, practices, initiatives and actions targeting OSH in digital platform work, highlighting the EU OSH strategic framework and the recently approved European Commission's directive for improving working conditions in platform work,[7] and providing an in-depth look at specific case studies.

4.3.1 Current legislation

EU-OSHA's report on regulations, policies and practices in platform work (EU-OSHA, 2022v) indicates the European Commission's EU Strategic Framework on Health and Safety at Work 2021-2027 as one of the main references on the topic. The OSH Framework Directive sets responsibilities for both employers and workers, but emphasises that the primary responsibility for worker safety and health lies with the employer (Article 5(3)). The directive outlines general principles for risk assessment, prevention and control measures, and mandates the informing, consulting, participation and training of workers and their representatives. According to the Directive, EU Member States must ensure proper oversight and enforcement of these obligations, typically through labour inspectorates and OSH agencies. The OSH Framework Directive is supported by specific directives (the so called *daughter directives*) that address particular risks, tasks and high-risk workplaces in more detail. However, both the OSH Framework Directive and its supporting directives only apply to 'dependent employment', and since most platform workers are classified as self-employed, the majority of those working via digital labour platforms are not covered by these directives (EU-OSHA, 2022v).

The correct determination of platform workers employment status is one of the key issues addressed by the European Commission's 'Directive on improving working conditions in platform work' (COM(2021) 762) approved by the European Parliament and Council in March 2024.[8] The directive also aims to address transparency in algorithmic management and the obligations of digital platforms to declare work and share relevant information with national authorities; it includes several provisions that are highly relevant to OSH and psychosocial risks.[9] For instance, the mandated transparency in algorithmic management and the imposition of human supervision (human in the loop) will increase autonomy and trust. In addition, the correct determination of platform workers' employment status is crucial because many of them are misclassified as self-employed, therefore excluded from protections under existing OSH regulations. The directive requires that Member States establish a rebuttable legal presumption of employment at national level, aiming to correct the imbalance of power between the digital labour platform and the person performing platform work. By establishing a presumption of employment and shifting the burden of proof onto the platforms – meaning that it is up to the platform to prove that workers are self-employed and not workers – the directive significantly improves the legal position of platform workers, so that those who are effectively in an employment relationship can be recognised as workers. The directive aims to extend the full range of OSH protections to these individuals, thus addressing a significant gap in the current regulatory framework.[10] However, one important limitation is that platform workers would still need to take a case in court, with the associated costs and risks that entails (Kullmann, 2022). Collective action and support from trade unions or worker associations can help mitigate these challenges.

At the national level, EU-OSHA's report on regulations, policies and practices in platform work (EU-OSHA, 2022v) also analyses several initiatives as case studies. The case studies illustrate a range of legislative and policy responses to OSH in digital platform work, including legal presumptions of

[7] https://www.europarl.europa.eu/news/en/press-room/20240419IPR20584/parliament-adopts-platform-work-directive

[8] On 8 February 2024, the Council and the Parliament reached a provisional agreement on platform work, which was approved by employment and social affairs ministers at the Council meeting on 11 March 2024. https://www.consilium.europa.eu/en/policies/platform-work-eu/

[9] On 8 February 2024 the Council and the Parliament reached a provisional agreement on platform work, which was approved by employment and social affairs ministers at the Council meeting on 11 March 2024. https://www.consilium.europa.eu/en/policies/platform-work-eu/

[10] The proposal introduces a rebuttable presumption of employment status, meaning that a platform worker is presumed to be an employee if certain conditions are met. Specifically, the Council has expanded the original criteria into seven distinct points, and if a platform meets at least three of these criteria, the worker is presumed to be an employee. These criteria focus on elements of control and dependency in the working relationship.

employment, requirements for algorithmic transparency and efforts to integrate platform workers into existing labour rights frameworks.

The Spanish Riders' Law (2021) introduces two crucial principles: first, a legal presumption of employment for delivery platform workers; and second, transparency in algorithmic decision-making processes. The (rebuttable) presumption of employment for delivery platform workers (riders) means that the burden of proof is shifted onto the platform, which must demonstrate that the worker is genuinely self-employed. The rationale of the law is to ensure that riders have access to the same labour rights and OSH protections as any workers. The law also amends the Workers' Statute to include the right to algorithmic transparency, meaning that platforms have to disclose to workers' representatives the parameters, rules and instructions used by algorithms when they affect working conditions and employment decisions. This aims to mitigate some psychosocial risks associated with algorithmic management, such as workload increases, time pressure and lack of autonomy (EU-OSHA, 2022q).

The Italian case study shows how a local initiative (the Bologna Charter) can inspire legislation at the national level. In Italy, workers can be classified under different legal statuses with decreasing levels of social protection: at one end of the spectrum the employees (with full protection), the two intermediate categories of 'employer-organised' workers (with a 'Contratto di collaborazione organizzata dal committente – co.co.org') and 'employer-coordinated' workers (with a 'Contratto di collaborazione coordinata e continuativa – co.co.co.'), and at the other end of the spectrum the self-employed. Italian courts have delivered varied judgments on the employment status of platform workers, with significant cases like the Supreme Court's ruling on Foodora riders and the Tribunal of Palermo's decision on Glovo riders, both leaning towards classifying these workers as employees. In response to the ambiguous status of platform workers, the Italian government enacted the Legislative Decree No. 101/2019, extending the scope of 'employer-organised' work to include digital platform workers and introducing specific rights for self-employed platform workers in the delivery sector. These rights cover transparency, fixed hourly wages, anti-discrimination, data protection and OSH provisions. The decree also ensures that platform workers are covered by national labour laws, including those related to OSH. According to the case study, the decree was inspired by a local initiative, the Bologna Charter of Fundamental Rights of Digital Labour in the Urban Context, consisting of a voluntary agreement, signed by several platforms in 2018, to provide a comprehensive set of rights for platform workers, including OSH management systems (risk assessment, provision of safety devices and insurance against accidents and occupational diseases); the right to refuse unsafe work; transparency of algorithmic management; fixed hourly income; work-life balance and the right to disconnect; and data protection (EU-OSHA, 2022z).

The third case study provides an analysis of the French legislative framework on digital platform work, which includes several laws aimed at improving the working conditions for platform workers. The El Khomri law, the Law on the Fight against Fraud and the Law on Mobility (LOM) collectively seek to clarify the employment status of platform workers and ensure their access to social protections. The El Khomri law (2016) grants self-employed platform workers the right to unionise, provides insurance for occupational accidents and diseases, establishes the right to disconnect and allows workers to reject tasks without penalties. The Law on the Fight against Fraud (2018) requires that platforms report worker income to tax authorities, thus enhancing transparency and aiding regulators to combat undeclared work. The Law on Mobility (2019) offers platform workers in the transport sector the right to refuse assignments and disconnect without penalties, and encourages platforms to create voluntary, non-binding charters outlining working conditions and risk prevention measures (EU-OSHA, 2022u).

The last case study describes initiatives undertaken by various labour and social security inspectorates across the EU to tackle the challenges of enforcing OSH regulations in digital platform work, by monitoring dispersed and mostly informal work arrangements. The Spanish inspectorates are particularly noted for their comprehensive approach, including efforts to ensure legal compliance and protect the rights of platform workers. Initiatives such as Spain's Strategic Plan 2018-2020 and the Riders' Law include measures for identifying and inspecting platform work. The Polish Labour Inspectorate extended OSH obligations to platform workers on civil contracts. In Belgium, the collaboration between Deliveroo and SMart – Société Mutuelle pour Artistes (Mutual Society for Artists) – ensured OSH protections to riders employed through SMart. However, Deliveroo ended the cooperation and adopted a self-employed business model, thereby removing the structured employee benefits that SMart provided, such as minimum wage guarantees, insurance and OSH training. This

decision led to significant controversy and criticism from labour advocates and workers (EU-OSHA, 2022aa).

4.3.2 Good practices

The report on report on regulations, policies and practices in platform work (EU-OSHA, 2022v) and the four case studies (EU-OSHA, 2022q; EU-OSHA, 2022u; EU-OSHA, 2022z; EU-OSHA, 2022aa) suggest a number of good practices that, if implemented, would ensure safer and healthier working conditions for platform workers.

Given the issues related to the unclear employment status of platform workers, one solution could be to adopt Poland's approach and extend OSH obligations to workers under 'civil contracts', which ensures that platform workers, even if classified as self-employed, receive necessary safety training, PPE and information about workplace hazards, including psychosocial risks.

Similarly, Italy's approach, combining national legislation and local initiatives like the Bologna Charter, provides a comprehensive framework for addressing the challenges of platform work. It highlights the importance of multi-level governance and the active involvement of local authorities, trade unions and worker organisations in improving working conditions in the platform economy.

At the company level, a crucial best practice is to conduct thorough and collective risk assessments to identify and prevent risks more effectively, like in the case of the Belgian cooperative SMart. By evaluating risks at an organisational level, the cooperative was better able to identify common issues that individual workers might overlook, and therefore develop standardised safety protocols. To complement this strategy, the Italian Bologna Charter emphasises the participation of workers in discussions about OSH to enhance the effectiveness of risk assessments.

Ensuring transparency in algorithmic management can help prevent psychosocial risks typically associated with algorithmic management, like excessive workload and lack of autonomy. The Spanish Riders' Law is a good example in that it requires that platforms disclose how algorithms influence working conditions and employment status. The Riders' Law has improved transparency and reduced occupational stress by making decision-making processes more predictable and fairer; however, its scope is limited to the delivery sector, while enforcement challenges remain. The EU directive on platform work aims to expand these protections, mandating human oversight of algorithms (human in the loop) and giving workers the right to contest automated decisions made by algorithms.

Finally, the case studies highlight that enforcement mechanisms are crucial for the effective implementation of OSH policies, and that inspectorates play a vital role in this regard. However, their efforts need to be complemented by better data collection, increased transparency and more consistent application of OSH standards across all forms of employment, including platform work.

5 Conclusions and policy pointers

The aim of this report was to present findings from EU-OSHA research on the topic of digitalisation and psychosocial risks; to this end, over one hundred documents, including reports, policy briefs, discussion papers and case studies were analysed. The report also provided some key findings from the OSH Pulse 2022 survey and the European Survey of Enterprises on New and Emerging Risks (ESENER 2019) in section 2. According to both surveys, a significant share of the workforce experience mental health issues such as fatigue, stress, anxiety and depression. Key psychosocial risk factors identified include severe time pressure, work overload, poor communication within organisations, lack of autonomy and exposure to violence or harassment. Findings from both surveys also conclude that digital technologies often exacerbate these risks by facilitating constant connectivity, increasing surveillance, and placing higher performance demands on workers.

Section 3 showed how different digital technologies, namely advanced robotics, artificial intelligence, smart digital systems, digital platform work and remote working technologies, may lead to and amplify many psychosocial risks, and primarily job insecurity, increased workload, cognitive overload, decreased autonomy and intensified surveillance, which collectively affect workers' mental health and wellbeing significantly. More specifically, AI and advanced robotics can be associated with fear of job loss, increased workload and cognitive overload. These technologies often trigger a fear of job loss among workers as they replace human tasks, leading not only to actual job displacement but also to a pervasive sense of job insecurity. Paradoxically, while these technologies are designed to streamline operations, they frequently result in increased workloads for remaining staff. This occurs because workers need to manage these technologies, leading to cognitive overload and continuous demands for upskilling, which can be overwhelming without adequate support. This section also explored how digitalisation affects different types of tasks in the workplace and differentiates between physical and cognitive, routine and complex tasks. The main psychosocial risk factors related to routine cognitive tasks are cognitive overload, since tasks that involve repetitive monitoring or data analysis can lead to mental fatigue, and fear of job loss, due to concerns that AI may replace roles traditionally requiring human judgment. By contrast, complex cognitive tasks, which involve higher levels of decision-making and problem-solving, are associated with upskilling needs and performance pressure. In both cases, preventive measures involve comprehensive training, worker involvement and participation and clear communication within the organisation. Psychosocial risk factors associated with the automation of routine physical tasks are safety concerns and deskilling, since the automation of manual tasks reduces skill requirements and potentially leads to underutilisation of human workers. By contrast, the automation of complex physical tasks is associated with psychosocial risk factors such as changes in job content and cognitive overload. Preventive measures include safety training and ergonomic adjustments, as well as worker engagement and job security assurances. Automation of combined cognitive and physical tasks face cognitive overload and job loss fears.

The adoption of smart digital systems, including wearable devices, wireless technologies and the Internet of Things (IoT), generates increases in surveillance and monitoring. This digital panopticon can significantly diminish workers' sense of privacy and autonomy, disrupt work-life balance and raise stress levels. Additionally, as these systems generate vast data, workers face the double challenge of having to process this information as well as making sure that it is not used against them. Digital platform work is associated with reduced job autonomy and job insecurity; in addition, platform workers often experience performance pressure and a lack of clear communication, with workers having little control over their schedules and workloads, dictated largely by platform algorithms, contributing to stress and anxiety. Finally, remote working technologies, by enabling work from home may also blur the boundaries between work and personal life. This often leads to longer working hours and the expectation of constant availability, contributing to burnout and reduced job satisfaction. Additionally, remote work can lead to communication issues, with workers feeling isolated from their colleagues and management, which can further diminish teamwork and support.

Section 4 examined regulation and good practices, at the EU and national level, aimed at mitigating the impact of digitalisation on OSH. According to EU-OSHA literature, there's a lack of specific laws addressing the impact of digitalisation on OSH; however, existing OSH regulatory framework still applies. In addition, rather than covering digitalisation broadly, current laws focus on specific topic areas, such as artificial intelligence, telework and digital labour platforms. The legislation on AI consists of both

national and EU-level initiatives aimed at balancing risks and benefits of AI. While national policies appear to prioritise economic gains over worker safety, lacking specific strategies for OSH concerns, the EU's AI Act – in spite of not having an OSH focus – seeks to ensure AI safety and respect for fundamental rights by addressing AI's impact on employment, including recruitment, task allocation and worker monitoring. Additionally, national strategies from countries like Germany, France, Sweden and Norway emphasise education, skill development and ethical considerations in AI adoption. For what concerns telework, we should differentiate between before and after the COVID-19 pandemic. Before the pandemic, some countries had specific legislation, including provisions for the right to disconnect, but the main reference was the EU Framework Agreement on Telework of 2002, which only served as guidance. Post-pandemic, there has been an increased focus on telework regulations, with discussions on issues like the statutory definition of telework, the right to request telework, the right to disconnect and ensuring OSH provisions. The European Parliament has addressed these concerns through a resolution on the right to disconnect and by urging Member States to develop national action plans. Finally, section 4 also reviews laws and regulations on digital platform work and describes the findings of some case studies of national initiatives. At the European level, the European Union's directive on improving working conditions in platform work stands out. Its aim is, among others, to address the classification employment status of platform workers. Additionally, various countries have implemented or proposed legislative reforms to regulate platform work, with examples including Spain's Riders' Law and Italy's legislative decree extending rights to platform workers. These initiatives emphasise the importance of extending labour protections to platform workers, ensuring transparency in algorithmic management and clarifying the employment status of platform workers to enhance their rights and safety.

5.1 Policy pointers

The findings from this review highlight that while digitalisation has the potential to improve working conditions, particularly for vulnerable workers, it also poses significant risks. By ensuring that new technologies are designed with the needs of all workers in mind, organisations can create more inclusive and supportive work environments. By suggesting specific interventions to prevent psychosocial risk factors, the report provides a framework that can be used by policymakers to improve current regulations, and by organisations to introduce preventive measures in the workplace, so that the benefits of adopting advanced digital technologies in the workplace are balanced with effective protection of workers' safety and health.

A proactive and human centred approach to OSH management is crucial

- Preventing psychosocial risks stemming from the digitalisation of work processes requires a **proactive and human-centred prevention-through-design approach** to OSH and risk management when they are implemented. A '**human-centred'** or '**human-in-command'** approach means that the **worker is at the centre and in command of the digital transformation, and not merely a passive subject of technology**.
- Jobs should be planned in such a way that not only constant heavy physical workload should be avoided, but also excessive homogeneity in tasks, to prevent a constant high mental workload. In addition, rest breaks should be planned into the workload.
- **Worker participation** should be fostered not only at the stage of adoption and use of the technology but also at the stage of design of the technology and any required change at the organisation level.
- **Comprehensive training and upskilling** programmes are essential to ensure that workers and managers are well-prepared to handle new technologies; in addition, reskilling and upskilling initiatives are crucial to alleviate fears of job loss, also among managers.
- **Ergonomic adjustments** should be made to ensure that the work environment is safe and comfortable, reducing physical strain on workers.
- **Psychological support services** are also crucial to help workers manage stress and mental health challenges.

Risk and workload assessments

- Employers' mandatory **risk assessments must cover risks stemming from digitalisation**. These risk assessments should be accompanied by robust policies that ensure adequate worker

information, participation, training, clear communication and supportive management practices. Such measures are essential not only for preventing the adverse effects of digitalisation but also for fostering a healthier, more secure and more productive working environment.

- The hierarchy of prevention principles enshrined in the legislation requires avoiding risks at source and **collective prevention measures** as the top priority. The value of this organisational approach is demonstrated by the case of the Belgian cooperative SMart – by evaluating risks at an organisational level, it was possible to identify common issues that individual workers might overlook, and therefore develop standardised safety protocols.
- Regular **workload assessments** and consequent adjustments are necessary to maintain a healthy work environment by ensuring tasks are distributed fairly and workers are not overburdened so as to prevent excessive pressure and cognitive overload.
- **Promoting flexible work arrangements** is essential for managing the psychosocial risks associated with digital technologies. The EU-OSHA literature recommends policies supporting work-life balance, such as flexible scheduling and the right to disconnect, which are particularly important to prevent the blurring of boundaries between work and personal life.

Promoting social interactions

- To combat isolation and improve communication among (remote and hybrid) team members and between remote workers and managers, the EU-OSHA literature emphasises the importance of promoting social interaction among workers. Strategies include regular team meetings, informal interactions and virtual collaboration platforms.
- In the context of remote working, comprehensive teleworking agreements can help set clear expectations and boundaries.

Foster trust and transparency

- To foster trust, both between employers and workers and towards the technology, it is important that organisations provide information on the technology and are transparent about how technology is used, if data and what data are collected, how decisions are made, and so on.
- Where digitalised systems are used to take or assist decision-making about workers, it is important that these systems are fair and unbiased.

Fill regulatory gaps for digitalisation

- The **current regulatory framework does not fully address new digitalisation challenges**. While existing regulations such as the directives on working time, health and safety (the OSH Framework directive) and work-life balance generally apply, they are not tailored to address the impacts of these new technologies, indicating a gap that needs to be filled.
- OSH needs to be embedded in directives, national legislation and stakeholder agreements on digitalisation when they are developed.
- **Emerging risks must be incorporated into OSH strategies** and produce tailored codes of practice and guidance on the application of general OSH legal provisions to different types of digitalisation. This involves engaging a broad range of stakeholders, including workers and workers' organisations to ensure that the strategies prevent psychosocial risks in a comprehensive and thorough manner, leading to more robust and responsive OSH policies.
- Combining national legislation and local initiatives, as shown in the Italian case study, provides a comprehensive framework for addressing the challenges of platform work, and highlights the importance of involving local authorities, trade unions and workers' organisations in governance to help ensure that these protections are enforced effectively.

In conclusion, the findings from this review of EU-OSHA's literature indicate a growing need to examine the impact of digitalisation on mental health. Research should focus on identifying the specific mental health challenges posed by digital technologies and developing evidence-based interventions. Policymakers need to create regulations that address these psychosocial risks, while practitioners should implement strategies that promote mental wellbeing in digital work environments.

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Appendices

Appendix 1 — Case studies in advanced robotics and artificial intelligence

	Case study	Description	Psychosocial risks mentioned	Solutions
1	Collaborative Robot Lifting Parts in an Automotive and Industrial Supplier (Slovenia) (EU-OSHA, 2023a)	A Slovenian-founded automotive and industrial supplier integrated a collaborative robot (cobot) into their production line to assist with lifting parts between workstations. The cobot **replaced physical, repetitive tasks**, allowing workers to focus on more cognitive ones like quality control.	▪ Cognitive overload/need for new skills. ▪ Fear of job loss (particularly among older workers). ▪ Job structure changes: increase in disjointed tasks, potentially raising cognitive load. ▪ Physical risks: potential for injuries from mishandling or malfunctions; considerations for different demographic groups, including those based on height and age.	The company actively addressed these psychosocial issues through: ▪ Worker training and qualifications (e.g., on operating and troubleshooting the cobot). ▪ Worker involvement and communications strategies. ▪ Emphasising a supportive culture that values innovation and worker wellbeing. The approach worked, as over time it led to increased acceptance and recognition of the cobot's benefits and reduced fears of job losses.
2	Cognitive and Physical Automation in a Sawmill Production Line (Sweden) (EU-OSHA, 2023b)	AI and robotics were introduced in a sawmill to automate the visual inspection and sorting of defective lumber. The system combines cognitive (AI-based defect identification) and physical (robotic handling) automation. The system replaced **physically strenuous and hazardous tasks** related to manual sorting and handling of lumber, as well as the **cognitive task** of visually inspecting and evaluating boards for defects.	▪ Physical safety risks from interacting with the multi-axial robot and machinery malfunctions. ▪ Changes in job content and skill requirements. ▪ Cybersecurity concerns, which can affect worker trust and security.	▪ Comprehensive training programs on operating the new system. ▪ Clear communication and documentation (e.g., about operational changes, safety protocols and procedures for emergency situations). ▪ Cybersecurity measures: the report suggests that general cybersecurity measures in place were deemed sufficient.

	Case study	Description	Psychosocial risks mentioned	Solutions
3	Artificial Intelligence-Based System for Product Inspection in Manufacturing (Germany) (EU-OSHA, 2023c)	A conglomerate specialising in various sectors implemented an AI-based visual inspection system using X-ray imaging for product inspection in one of its German branches. The system automates the **cognitive task** of inspecting and evaluating workpieces for defects. The task is **repetitive** but requires high concentration and attention to detail, leading to cognitive strain.	▪ Cognitive overload. ▪ Fear of job loss. ▪ Need for upskilling/reskilling.	▪ Extensive worker training. ▪ Worker involvement and feedback. ▪ Clear communication and documentation. ▪ Attention to ergonomics and wellbeing. ▪ Social support structures (e.g., counselling for workers concerned about job losses).
4	Multi-Axis Robots for Assembly Automation and Autonomous Guided Vehicles in Manufacturing (Germany) (EU-OSHA, 2023d)	This case study explores the implementation of multi-axis robots and autonomous guided vehicles (AGVs) in a manufacturing plant of a conglomerate specialising in various sectors, including automation and digitalisation. The automation replaced **physical, repetitive tasks** such as lifting and transporting components, and cognitive tasks like visual inspections for quality control.	▪ Cognitive overload. ▪ Fear of job loss. ▪ Changes in task structure and job content. ▪ Need for upskilling/reskilling.	▪ Training/upskilling and reskilling workers to handle new technologies. ▪ Worker engagement and involvement. ▪ Worker support structures (e.g., to address fears of job loss). ▪ Communication and feedback.
5	Collaborative Robot that Automates Sewing of Bags in Automotive Supplier Industry (Portugal) (EU-OSHA, 2023e)	The case study explores the implementation of a collaborative robot (cobot) at a factory (automotive supplier) in Portugal. The cobot replaced **manual** sewing **tasks**, which involved repetitive movements and precision-based repetitions in bag assembly.	▪ Deskilling – shift from manual sewing skills to operating a cobot. ▪ Lack of trust and initial resistance and towards the cobot.	▪ Reskilling and training: workers received comprehensive training to operate the cobot. ▪ Gradual introduction of the tech (to deal with lack of trust). ▪ Feedback system.

	Case study	Description	Psychosocial risks mentioned	Solutions
6	Artificial Intelligence-Based Vehicular Automation Fitted to Excavators to Automate Trenching (United States) (EU-OSHA, 2023f)	AUS-based start-up that develops software and hardware to automate construction equipment, focusing on excavators for trenching tasks: The technology uses GPS, cameras and AI to enable either fully autonomous or supervised autonomous operation. The system replaces **both cognitive** (monitoring for obstacles) **and physical** (manual trenching) **tasks.**	▪ Cognitive overload.	▪ Worker and site safety and accident prevention. ▪ No explicit mention of addressing cognitive overload directly.
7	Robotic System for Palletising and Depalletising Products (Denmark) (EU-OSHA, 2023g)	The Danish multinational company (manufacturer of industrial machinery) adopted a hybrid system combining an unfenced multi-axial robot with an AI-vision system. This technology **automates both cognitive and physical task**s related to depalletising and palletising products.	▪ Cognitive overload and performance pressure – AI system made jobs less repetitive, with more problem-solving tasks; some workers compare their performance with AI's. ▪ Fear of job loss. ▪ Shift in job requirements.	▪ Extensive worker training, ensuring smooth transition to new roles. ▪ Open communication for feedback and adjustments, thereby improving job satisfaction and workplace safety.
8	AI-based System for Visual Recognition of Hazardous Particles in Air Samples (Germany) (EU-OSHA, 2023h)	A ministerial research institute in Germany employing over 500 people, involved in various research topics related to OSH, developed an in-house AI-based system to support researchers in identifying specific fibre materials in air samples. The system automated a **highly repetitive and dull task**.	▪ No specific psychosocial risks mentioned.	▪ No mention of specific measures taken by the company to address psychosocial issues.

	Case study	Description	Psychosocial risks mentioned	Solutions
9	AI Software Supporting Physicians in Colonoscopy Diagnostic Tasks (Germany) (EU-OSHA, 2023i)	Use of AI software in an oncological centre to assist physicians in diagnosing during colonoscopy procedures: The AI system processes real-time video data from colonoscopies, identifying polyps and adenomas at early stages by displaying visual indicators on the monitor. The system does not replace, but **assists** the physician performing a **cognitive task**.	▪ Cognitive overload for the physicians.	▪ No mention of explicit solutions to mitigate the increased cognitive load due to the AI system. However, it is noted that breaks can be taken between procedures, suggesting an understanding of managing workload and decision fatigue among the medical staff.
10	Advanced Robotic Systems for Inspection and Maintenance of Gas and Oil Infrastructure (Norway) (EU-OSHA, 2023j)	A Norwegian gas infrastructure company introduced two advanced robotic systems to assist in the inspection and maintenance of pressure tanks. The robots provide images and data from inside the tanks, reducing the need for human entry. The advanced robotic systems replaced primarily **physical tasks** and reduced human exposure to hazardous and physically demanding environments.	▪ The company mentions a possibility of cognitive overload, but no operators reported it. ▪ Fear of job loss: Inspectors initially experienced fear of job loss, but management intervention helped ease these fears.	▪ Management intervention and communication to emphasise the benefits of the new robotic systems (safety and healthier work environment). ▪ Reassurance on job security to build acceptance and trust in the new technology among the workforce. ▪ Worker involvement.
11	A Robot Automating Manure Cleaning to Maintain Hygiene in Livestock (Netherlands) (EU-OSHA, 2023k)	This case study focuses on a Dutch technology developer that produces advanced robotics and AI-based systems for dairy farming. Among their innovations is an autonomous cleaning robot designed to maintain hygiene within cow enclosures by collecting and disposing of manure. The technology replaces physical, routine tasks.	▪ Not explicitly mentioned, but implicitly the study mentions potential psychosocial risks, such as fear of job loss, lack of training and the need for a basic level of technological understanding.	▪ Training and worker qualifications are a major focus to ensure successful technology implementation.

	Case study	Description	Psychosocial risks mentioned	Solutions
12	Smart Automation to Reduce Physically Demanding Work in Manufacturing of Steel Products (Sweden) (EU-OSHA, 2023l)	This Swedish company, specialised in manufacturing steel products, has integrated smart automation technologies (AVGs and automated production line machinery) into its manufacturing processes. The introduction of these technologies has automated several **monotonous and repetitive physical tasks** within the manufacturing process	▪ Fear of job loss – initially. ▪ Trust in the technology (e.g., by second-guessing or altering the course of the machinery rather than allowing it to follow its programmed path).	▪ To address these challenges, the company implemented biometric doors and barriers to reduce unauthorised interactions between workers and machinery. ▪ Retraining and upskilling for new roles in monitoring and maintenance, effectively addressing initial concerns about job loss.
13	Advanced robotics in injection-moulded and extruded plastic products manufacturer reducing physical demanding tasks (Sweden) (EU-OSHA, 2023m)	This Swedish manufacturer of plastic products, such as non-invasive breath-sampling devices employed dual-armed lightweight cobots for laboratory sample preparation. The cobot automates several **monotonous and repetitive tasks** that were previously performed manually by skilled workers.	▪ The case does not specifically mention psychosocial risks.	Specific solutions to psychosocial risks are not mentioned, however the company, does engage in: ▪ Retraining and upskilling workers for new roles that arise as a result of automation. ▪ Ensuring worker safety and ergonomics. ▪ Involving workers in the implementation process of cobots.
14	AI-based Software to Increase Fact-Checking's Speed, Scale, and Impact (United Kingdom) (EU-OSHA, 2023n)	A registered charity in England employs AI-based tools for media fact-checking. The AI tools use natural language processing and machine learning techniques to automate the first stages of the fact-checking process. The technology **supports cognitive tasks** by assisting rather than replacing human fact-checkers.	▪ Fact-checkers are exposed to harmful content (e.g., violence, conspiracy theories) that can be distressing. However, the AI tools do not appear to increase the risk.	To mitigate psychosocial risks, the organisation provides: ▪ Peer support, regular breaks and personal flexibility at the workplace. ▪ Training for using AI tools efficiently. ▪ Ethical audits of the tools.

	Case study	Description	Psychosocial risks mentioned	Solutions
15	AI-based Material Quality Control Measures (Sweden and Norway) (EU-OSHA, 2023o)	The company is described as a systems integrator that operates within the industrial manufacturing sector, providing custom automation solutions that incorporate advanced robotics and AI. The technology aims to replace cognitive and physical tasks involved in material sorting, traditionally done by humans.	▪ The case study does not explicitly mention psychosocial risks. It mentions (not as a primary risk) that workers may become stressed when they realise that machines perform tasks at a higher frequency.	The company's approach includes comprehensive safety measures and in-person training to ensure the workforce can effectively use and maintain the new AI-supported systems. An intuitive user interface is designed to reduce operational stress, facilitating easier interaction with the technology and contributing positively to occupational safety and health.
16	Drones Inspecting Worksites of Gas Infrastructure Operator (Norway) (EU-OSHA, 2023p)	A Norwegian state-owned gas infrastructure company uses AI-supported drones for worksite inspections. These drones are deployed to identify obstacles or hazards within large gas transportation infrastructure sites. The technology automates **cognitive routine** tasks by analysing visual data.	▪ The case does not explicitly list psychosocial risks, but rather implies benefits through reduced need for workers to perform potentially hazardous manual inspections.	

Appendix 2 — Case studies on platform work

	Case study	Description	Psychosocial risks mentioned	Solutions and policies
1	Occupational safety and health risks of parcel delivery work organised through digital labour platforms (EU-OSHA, 2022i)	The study looks into the occupational safety and health (OSH) risks associated with parcel delivery work intermediated through a digital labour platform (low skilled, on-location tasks), and it further covers OSH risk prevention and management. It builds on a review of recent academic and grey literature, providing a comparison between parcel delivery in the traditional economy and the platform economy. The study also includes interviews with representatives from three platforms and two platform workers, offering a mix of views from both the supply (platforms) and demand (workers) sides. These interviews cover both global platforms with international operations and local platforms focused on specific markets.	▪ Fear of job loss: due to the precarious nature of platform work. ▪ Workload increase and time pressure: caused by algorithmic management and the demand for speedy deliveries. ▪ Lack of trust and lack of autonomy: stemming from the opaque nature of algorithms and platform control over work. ▪ Long or irregular working hours: to meet the high demand, especially evident during the COVID-19 pandemic. ▪ Poor communication and poor social relationships: due to the isolating nature of platform work and digital intermediation between workers and clients. ▪ Conflicting demands and lack of role clarity: as a result of varied tasks and expectations without clear guidelines. ▪ Sense of unfairness and lack of training: linked to algorithmic evaluation and lack of preparation for handling job-specific risks.	The report calls for improved recognition of platform work under OSH regulations, advocating for clearer definitions of employment relationships to ensure platform workers are covered by OSH protections. It also suggests the need for platforms to provide insurance, training and appropriate equipment, as well as for policies that support collective representation and bargaining for platform workers.

	Case study	Description	Psychosocial risks mentioned	Solutions and policies
2	Occupational Safety and Health Risks of Handiwork Provided Through Digital Labour Platforms (EU-OSHA, 2022h)	The report explores the OSH risks associated with handiwork provided through digital labour platforms, emphasising the prevention and management of these risks. Its methodology is based on reviewing academic and grey literature and conducting interviews with three platform workers and three platforms intermediating handiwork.	▪ Professional isolation: arising from working independently, leading to a lack of social interactions and support networks. ▪ Work-life balance and job/income insecurity: concerns due to the precarious nature of platform work, fluctuating demand and the dependency on client ratings for obtaining work, potentially affecting mental health and financial stability. ▪ The importance of rating or reputation mechanisms is highlighted, affecting work allocation and potentially leading to stress and emotional demands on workers.	Solutions include the provision of educational documentation and guidelines on task performance and conduct by platforms, insurance protections (accident and injury, accidental death and disability protection) for ‘Elite Taskers’, and the implementation of measures to protect clients and platform workers during the COVID-19 pandemic. The report suggests that while platforms offer fragmented health and safety initiatives, there is no comprehensive OSH policy in place, primarily due to the classification of workers as self-employed or non-professionals.

	Case study	Description	Psychosocial risks mentioned	Solutions and policies
3	Occupational Safety and Health Risks of Remote Programming Work Organised Through Digital Labour Platforms (EU-OSHA, 2022l)	This case study investigates OSH risks associated with remote programming work mediated by digital labour platforms (high skilled, online tasks). It examines how these risks compare to traditional employment settings and explores the effectiveness of risk prevention and management strategies implemented by platforms. The methodology includes a comprehensive literature review and interviews with three platform workers and two platforms. It highlights the primary role of algorithmic management in work allocation and the significant reliance on remote work arrangements.	▪ Professional isolation: the separation from physical workplaces and direct interactions, leading to feelings of loneliness and disconnection. ▪ Work-life balance issues: the blurred lines between personal and professional life, potentially leading to overwork and stress. ▪ Job/income insecurity: the unpredictable flow of work and income due to competition and platform algorithms, affecting mental health and financial stability. ▪ Additionally, the reliance on client ratings for future work opportunities exacerbates stress and emotional demands, indicating a need for regulatory oversight to protect remote programmers in the digital platform economy.	The report suggests that comprehensive OSH policies for remote programming work are largely absent, with platforms leaving workers to manage risks independently. Some platforms offer basic guidelines or support for mental health through newsletters and blog posts. However, these efforts are fragmented, and no general OSH policies were identified. The report indicates a need for platforms to take a more active role in ensuring the safety and health of their workers, including proper ergonomic practices and measures to address professional isolation and work-life balance. The report highlights that the classification of most remote programming workers as self-employed or occasional workers leads to a lack of comprehensive health and safety policies from platforms. The global nature of digital labour complicates the applicability and enforcement of EU OSH regulations.

	Case study	Description	Psychosocial risks mentioned	Solutions and policies
4	Occupational Safety and Health Risks of Online Content Review Work Provided Through Digital Labour Platforms (EU-OSHA, 2022j)	This case study addresses the OSH risks associated with online content review work provided through digital labour platforms. It defines such work as the examination of user-generated content to ensure it does not contain illegal or abusive materials. Methodologically, the study is based on a literature review and interviews with a platform worker and a global platform. It explores how content review work is organised, highlighting its rise in prevalence due to the rise of social media platforms and technological advancements.	▪ Exposure to violence, crime, abuse and illegal content leading to stress, long-term psychological harm and post-traumatic stress disorder. ▪ Fatigue, distress and depression due to the sensitive nature of the reviewed content. ▪ Stress caused by algorithmic management, work under high time pressure, competition and the need to maintain a good rating for future task allocation. ▪ Professional isolation due to individualised and remote work settings, lacking social support, leading to mental health issues.	The study notes a lack of comprehensive OSH policies and support from platforms for online content reviewers. Some platforms suggest taking regular breaks, but overall, there is limited guidance on health and safety. The global nature of the work complicates the applicability of EU legal frameworks and enforcement of relevant rules. Suggestions for improvement include mandatory flags for work that may cause psychological harm, training programmes for content reviewers and minimum counselling standards for client companies. The report calls for the introduction of minimum standards and rights for online content reviewers, regardless of their employment status or location, to address the unique OSH risks associated with this type of work.

The European Agency for Safety and Health at Work (EU-OSHA) contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1994 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

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