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THE IMPACT OF DIGITALIZATION ON WORKERS' SAFETY AND HEALTH

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Abstract: *The present study aims to explore current trends, emerging risks, and the potential effects of digitalization on occupational safety and health. Its specific objectives include analyzing the implications of digital system implementation for worker safety and well-being and examining the types and adoption patterns of digital technologies across organizations. The research was conducted among 96 organizations in Romania, focusing on identifying the range of digital solutions integrated into their operations. The final section of the paper discusses the main conclusions derived from the study, along with the current research limitations and potential directions for future investigation in this field.*
Key words: *digitalization, safety and health of workers, emerging risks.*

1. INTRODUCTION

The shift toward a digital economy has become a central theme in recent academic research, as technological progress has triggered profound transformations and innovations across virtually all areas of human activity. The accelerated evolution of digital technologies has reshaped everyday life, economic systems, organizational development, and broader societal dynamics. Digitalization has enabled organizations to modernize and enhance their capacity for innovation. For both employers and employees, the integration of emerging technologies—such as robotics, artificial intelligence, digital platforms, and intelligent systems—has redefined the structure of workplaces and the manner in which tasks are carried out, consequently affecting the overall quality of working life. [1].

The technological, social, and organizational transformations driven by digitalization offer significant potential to enhance working conditions; however, they also give rise to new challenges and emerging risks for workers. Strengthening job quality and fostering a proactive culture of risk prevention within organizations are essential, particularly amid the profound changes brought about by the digital transformation of work. In the scientific literature, numerous definitions are provided for the concepts of *digitalization*, *digitization*, and *digital transformation*, several of which are summarized in Table 1.

Broadly speaking, digitalization represents an extensive process of technological transformation that integrates digital tools and systems into organizational operations and, more generally, into society. The spread of digital technologies has enabled employees to perform their professional duties from locations other than those provided by the employer, most often from home or other remote settings, while simultaneously enhancing productivity through the use of diverse digital solutions.

2. OPPORTUNITIES AND RISKS OF DIGITALIZATION

The data required for identifying opportunities and risks of digitalization for this study were collected from the Scopus database.

Digital technologies provide essential services and solutions in all sectors of the economy and society. Their integration into the workplace changes the way we work, but also

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where and when we work. Digital technologies are also reorganizing the future of work, such as the types of jobs available, as well as the way work is performed, organized and managed. Change is inevitable in Europe's workplaces. No sector is immune as companies introduce digital technologies that have the potential to increase productivity, for example by automating tasks or digitally managing workers at traditional workplaces (e.g. at the employer's premises), remote workplaces or home jobs.

In an era shaped by the Internet of Things, artificial intelligence (AI), big data analytics, cloud computing, algorithmic systems, collaborative robotics, augmented and virtual reality, additive manufacturing, and digital platforms, emerging technologies increasingly define how workplaces operate. These innovations generate numerous opportunities but also introduce challenges, particularly within remote and hybrid work arrangements, as summarized in Table 2.

While remote work offers considerable advantages for employees, it also presents specific occupational safety and health concerns. Research in this field indicates that the most significant risks are associated with psychosocial factors and musculoskeletal disorders. To mitigate these issues, both employers and workers should implement measures that promote safe and ergonomic working environments, as well as maintain consistent, transparent communication within teams and with management.

Table 1

Definition of concepts.

Concept	Definition
Digitization	- Denotes the transformation of analog information into a digital format through technological means. [5]
Digitalization	- Represents a process of societal transformation driven by digital technologies, through which increasingly large social and economic spaces become interconnected. It entails a core structural change using digital tools and exploiting the opportunities provided by digital media. [5] - A fundamental process primarily driven by technological innovation. [6]
Digital transformation	- Refers to a process that requires specific competencies in applying innovative digital technologies to enhance economic performance and improve overall quality of life. [7] - Involves the adoption of emerging digital technologies, such as mobile systems, artificial intelligence, cloud computing, blockchain, and the Internet of Things (IoT), to achieve substantial business advancements, optimize customer experience, streamline operations, and develop new business models. It represents an ongoing process of integrating digital technologies into daily organizational practices, recognizing agility as a central mechanism for strategic renewal of the business model, collaboration, and organizational culture. [8] - Describes a fundamental change process enabled by the innovative application of digital technologies and the strategic use of essential resources and capabilities, with the goal of achieving radical improvement within an entity.

Table 2

Opportunities and challenges associated with remote or hybrid work

Opportunities	- Promotes flexibility in working hours and reduces commuting time between home and the workplace, thereby lowering the risk of commuting-related incidents. [4] - Supports improved work-life balance and greater control over personal schedules. - Enhances employee autonomy and responsibility in performing job-related tasks.
Challenges	- Emergence of psychosocial risks linked to decreased social interaction, absence of direct communication with colleagues or supervisors, extended working hours, and the blurring of boundaries between work and personal life. [2] - Increased work intensity, the expectation to remain continuously connected, accelerated work pace, fewer rest periods, and higher performance pressure. [2] - Potential infringement of privacy and confidentiality due to the growing use of digital monitoring tools (e.g., tracking software, GPS systems, recording devices). [4] - Necessity for employers to ensure compliance with ethical and legal standards when implementing employee monitoring systems. [4] - Ergonomic risks stemming from inadequate or poorly designed home workstations. [4]

3. WORKING ON DIGITAL PLATFORMS

According to a report of the EU-OSHA entitled "Digital Work Platform and Safety and Health at Work: Overview of Regulation, Policies, Practices and Research", a digital work platform is defined as an online system or marketplace that operates through digital technologies, often including mobile applications, and is owned or managed by a company. Its primary function is to facilitate the matching of labor demand with the supply of services provided by platform workers. A digital platform worker is described as an individual who performs intermediary work through such a digital platform, exercising varying degrees of autonomy or control, irrespective of their formal employment status.

A review of the existing literature addressing occupational safety and health in the context of digital labor platforms was conducted to examine how work is organized and to assess the working conditions of individuals engaged in platform-based activities. This employment model has grown significantly in popularity in recent years, offering various advantages alongside notable risks for workers' safety and health, which are outlined in Table 3. In summary, while platform-based work presents new and flexible opportunities for workers, it also introduces considerable challenges. To mitigate the risks associated with this emerging form of employment, it is essential to establish clear regulatory frameworks and implement effective measures aimed at safeguarding workers' rights and promoting their overall well-being.

4. AUTOMATION-ROBOTICS OF WORK

According to the *Safe and Healthy Workplaces Campaign 2023–2025: "Safe and Healthy Work in the Digital Age"*, launched by the European Agency for Safety and Health at Work (EU-OSHA), automation is defined as *a device or system capable of performing, either partially or entirely, a function that has previously been, or could potentially be, carried out by a human being* [7]. A wide range of automated systems and robotic technologies are currently utilized across multiple sectors, including industrial robots, automated machinery and equipment, drones, process automation systems for industrial or administrative operations, and automated transport solutions.

Table 3

Opportunities and challenges associated with work on digital platforms

Opportunities	- Facilitates the inclusion of workers in the labor market and offers increased flexibility and creativity in organizing work, as most platform-based activities are performed independently and outside traditional organizational settings. - Contributes to achieving a more balanced relationship between professional and personal life. - Provides greater autonomy and self-management in task execution. - Encourages the development of technical competencies and communication skills among workers.
Challenges	- Can negatively affect workers' psychosocial well-being due to employment insecurity. Many platform workers operate under ambiguous legal status, frequently as self-employed individuals, lacking the protections, benefits, and structured working conditions afforded to traditional employees (e.g., stable income, regulated working hours, occupational benefits). - Reduces job predictability and income stability, as workers often face fluctuating workloads and irregular schedules associated with self-employment. - Increases exposure to psychosocial risks such as isolation, excessive working hours, and blurred boundaries between professional and personal life, emphasizing the need for adequate working conditions. - Highlights the insufficient regulatory framework concerning occupational safety and health protection for platform workers. - Contributes to a sense of professional and social isolation stemming from the decentralized and individualized nature of platform work. - Limits opportunities for professional growth, skill development, and accurate competence recognition, leading to potential skill mismatches.

The main opportunities and challenges associated with automation and robotization in terms of workers' safety and health are outlined in Table 4. To minimize the risks linked to these technologies, careful attention must be paid to how they are implemented. Ensuring a gradual and well-managed transition is crucial to safeguarding employees' safety, rights, and overall well-being.

Artificial intelligence (AI) represents a rapidly evolving field encompassing numerous applications and opportunities that are reshaping job structures and work demands. Although AI-based systems bring considerable advantages to workplace processes, ongoing debates highlight their potential implications for occupational safety and health. A synthesis of the primary opportunities and challenges related to the use of AI in the workplace is presented in Table 5.

Table 4

Opportunities and challenges associated with automation and robotization in the workplace

Opportunities	- Enhances productivity and operational efficiency, allowing employees to focus on more creative, complex, and value-added tasks. - Reduces workers' exposure to hazardous environments and physical risks by minimizing manual operations, repetitive tasks, and contact with harmful substances. [9] - Improves workplace ergonomics and working conditions, lowering physical strain and stress through automation of demanding and repetitive activities. [1,9] - Promotes workplace flexibility and supports the inclusion of vulnerable groups (e.g., older or disabled workers), enabling longer participation in the workforce. [9]
Challenges	- May negatively influence psychosocial well-being through perceived job insecurity resulting from work restructuring, automation, and changes in job content. [1,4] - Resistance among employees toward adopting new digital technologies may hinder effective implementation. [11] - Creates emerging risks associated with the complexity of human–machine interaction, including programming errors, human mistakes, and insufficient training. [1,4] - Introduces new types of hazards such as exposure to electromagnetic fields, noise, vibration, and radiation. - Can generate technological stress—manifested as anxiety, frustration, demoralization, or cognitive fatigue, linked to continuous digital interaction. [2] - Reduces interpersonal contact, leading to feelings of isolation and decreased social cohesion at work. - Requires workers to develop new knowledge and skill sets to adapt to evolving technological environments. [11] - Highlights the necessity of continuous training and lifelong learning to maintain employability and align with changing job requirements.

Table 5

Opportunities and challenges related to the use of artificial intelligence in the workplace

Opportunities	- Enhances productivity and process efficiency through rapid data analysis and optimization of workflows, reducing operational delays and costs. [9] - Strengthens monitoring and risk management by enabling the collection and processing of extensive datasets to identify and mitigate workplace hazards. [9] - Improves the user experience by incorporating intelligent assistants and conversational bots, fostering more natural and intuitive human–technology interaction.
Challenges	- May pose psychosocial risks such as stress, burnout, and anxiety due to organizational changes induced by AI adoption. [5] - Can trigger feelings of job insecurity as automation replaces certain roles or alters traditional job structures. [5] - Reduces decision-making autonomy and perceived control over work processes, affecting mental well-being. [6] - Raises ethical and accountability concerns regarding liability when AI systems make incorrect or harmful decisions. - Increases concerns about data security and privacy, particularly regarding the protection of personal information used to train AI models. [6] - Risks producing inaccurate or biased outcomes when trained on incomplete, low-quality, or unrepresentative datasets, thereby affecting reliability and fairness

Table 6

Opportunities and challenges associated with the use of smart digital systems

Opportunities	- Enhances occupational safety by continuously monitoring environmental parameters (e.g., noise, air quality, chemical exposure, radiation) and issuing alerts in hazardous situations, contributing to improved worker performance and satisfaction. [15] - Enables real-time assessment of workers' physical condition through monitoring of vital parameters, supporting health management. [15] - Increases efficiency and productivity by providing workers with contextual information and automated recommendations.
Challenges	- Necessitates balancing functionality with usability—battery life, data processing capacity, adaptability to multiple users, and performance in diverse environments. [15] - Requires standardized testing, certification, and regulatory updates to ensure compliance and safety of smart technologies. - Calls for improved digital competence among workers to ensure successful integration of smart systems into daily operations. [15] - Potential reluctance toward adopting new digital tools may lead to psychosocial strain, including privacy concerns and stress from constant monitoring. - Demands robust cybersecurity and data protection strategies to prevent unauthorized access to personal or sensitive data. - System performance depends heavily on data quality; inaccurate or incomplete data can lead to errors, increasing the risk of adverse events. - Introduces new physical, cyber, and psychosocial risks stemming from system malfunctions or cyberattacks. - Further research is required to develop reliable connectivity solutions for complex or interference-prone environments (e.g., underground or industrial areas). [15]

5. INTELLIGENT DIGITALIZED SYSTEMS

The emergence of smart digital systems has accelerated significantly with the advent of the Fourth Industrial Revolution (Industry 4.0). The continuous advancement and refinement of digital technologies have fostered the creation of innovative occupational safety and health monitoring solutions, enabling organizations to maintain a higher and more effective standard of worker protection.

The implementation of such systems provides substantial advantages, including enhanced efficiency, productivity, and overall safety across various sectors. However, despite these benefits, additional research and practical measures are necessary to address the associated risks and limitations. Equally important is the need to identify strategies that promote greater acceptance and trust among workers regarding the use of smart digital technologies in their daily activities.

The organizations included in the analysis were classified according to their number of employees as follows: large enterprises (more than 250 employees), medium enterprises (between 51 and 250 employees), small enterprises (between 11 and 50 employees), and micro-enterprises (between 1 and 10 employees) (Figures 1–6). The primary objective of this research was to obtain an informed understanding of the level of digital system integration within Romanian organizations. In the examined cases, digitalization did not represent a radical transformation of existing processes but rather a systematic reconfiguration, reorganization, and optimization of operational procedures within current structures.

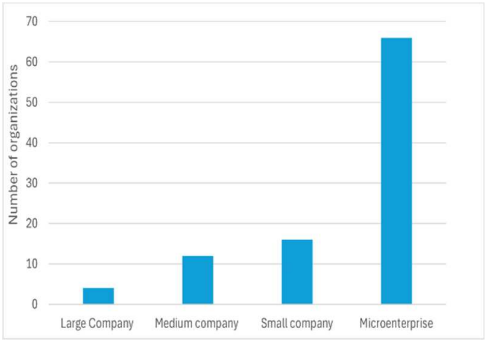

Fig. 1. Distribution of the organizations participating in the study.

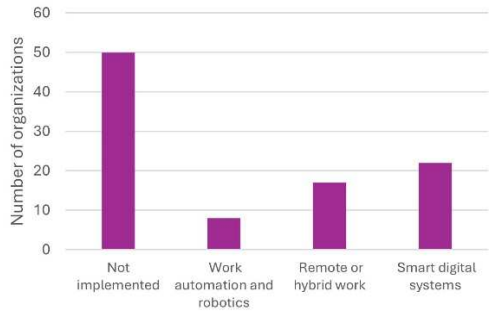

Fig. 2. Distribution of digital solutions adopted by the organizations included in the study.

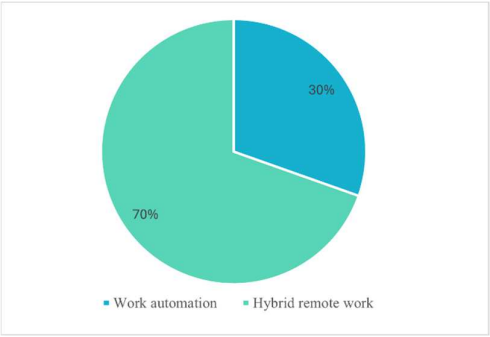

Fig. 3. Proportion of digital systems implemented by large organizations.

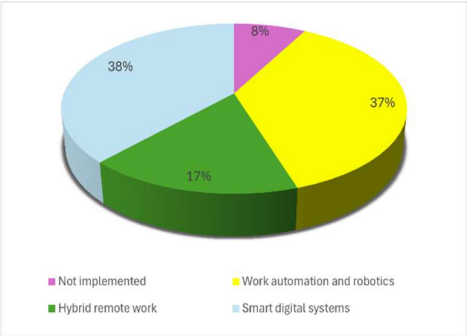

Fig. 4. Share of digital systems integration in medium-sized companies.

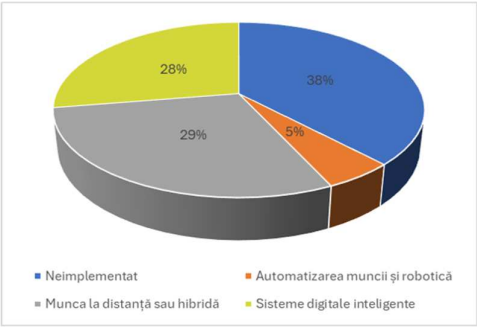

Fig. 5. Share of digital systems integration in small businesses.

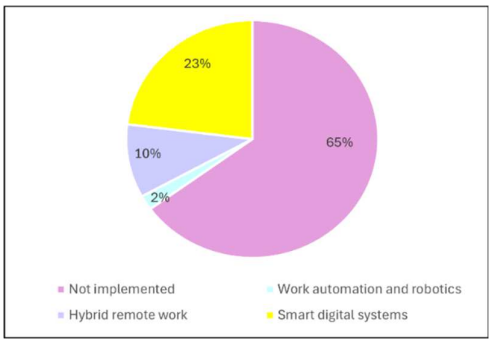

Fig. 6. Proportion of digitalized systems integrated in micro-enterprises.

6. CONCLUSIONS

Future work environments are expected to undergo substantial transformations, characterized by a shift from specialized tasks toward more complex, dynamic, and digitally mediated forms of work. These changes require increased attention from all stakeholders involved in occupational safety and health management. Numerous studies have acknowledged the emergence of new risks associated with technological advancement; however, it remains essential to strengthen preventive strategies aimed at minimizing occupational accidents and diseases and to ensure continuous adaptation to the evolving nature of these challenges.

Continuous and proactive risk assessment represents a fundamental component of effective occupational safety management and the promotion of a genuine culture of prevention in the workplace. In an era of constant technological and organizational change, it is crucial to anticipate, identify, and evaluate potential hazards that may cause occupational injuries or illnesses, and to implement preventive strategies from the earliest stages of technology, product, and process design.

As work environments become increasingly digitalized, psychosocial and organizational factors are gaining importance, particularly in how they influence the management and perception of risk. While numerous studies indicate that digitalization contributes to a reduction in workplace accidents, it simultaneously introduces new categories of risks, many of which are associated with occupational and psychosocial disorders.

Given the diversity of economic sectors and the specific characteristics of different professions, there is a clear need for sector-specific research aimed at identifying targeted solutions. These should address key priorities such as: promoting sustainable human resource development; strengthening workers' skills, creativity, and digital competence; enhancing employee motivation and resilience; ensuring privacy and data protection; and developing mechanisms to mitigate emerging risks while maximizing the benefits of digital transformation.

For most organizations, innovation, automation, and digital integration have become essential strategies for optimizing equipment, systems, and operational processes, ultimately enhancing competitiveness in an increasingly dynamic economic environment. Nevertheless, the deployment of digital technologies and artificial intelligence in the workplace must always respect ethical principles and safeguard workers' mental health and well-being. Their use should not result in excessive surveillance or intrusive monitoring practices carried out in the name of productivity, as demonstrated by previous studies [17–19].

A new conceptual and regulatory framework is required to address the growing complexity of contemporary work environments, particularly concerning mental health. Existing legislative and policy instruments are no longer adequate to fully ensure the protection of employees' health and safety; therefore, comprehensive updates and improvements are necessary at both the national and European levels.

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Impactul digitalizării asupra securității și sănătății lucrătorilor

Scopul acestui studiu este de a identifica tendințele, riscurile emergente și impactul potențial al digitalizării asupra securității și sănătății lucrătorilor la locul de muncă. Obiectivele stabilite pentru acest studiu au fost următoarele: identificarea consecințelor implementării sistemelor digitale asupra securității și sănătății lucrătorilor, precum și identificarea tendințelor, respectiv a sistemelor digitale implementate în cadrul organizațiilor. Lucrarea cuprinde rezultatele obținute in urma unui studiu realizat in cadrul a 96 de organizații din Romania. Cercetările efectuate in aceasta lucrare au fost îndreptate spre identificarea tipurilor de soluții digitale implementate de acestea. În ultima parte a lucrării sunt prezentate concluziile, precum și limitările actuale ale cercetării în acest domeniu.

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